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JOURNAL OF ELECTRICITY

POWER AND GAS

Devoted to the Conversion, Transmission and Distribution of Energy

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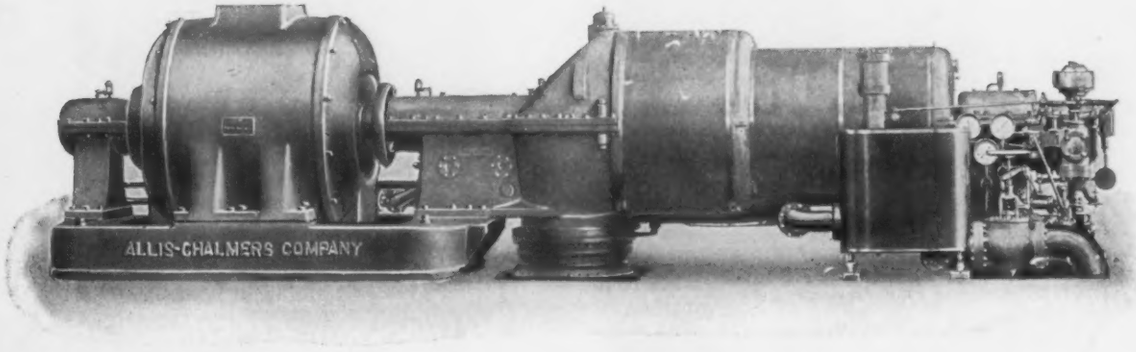

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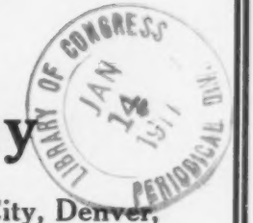

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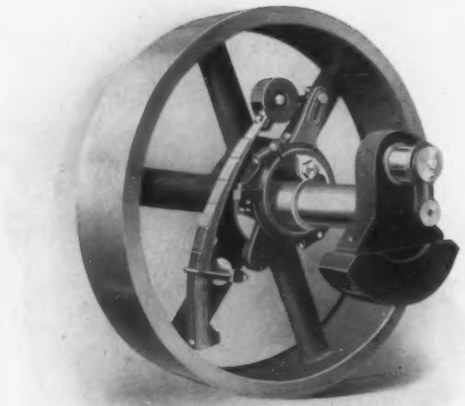

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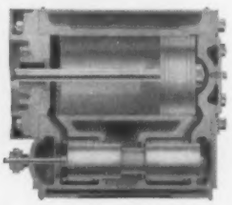

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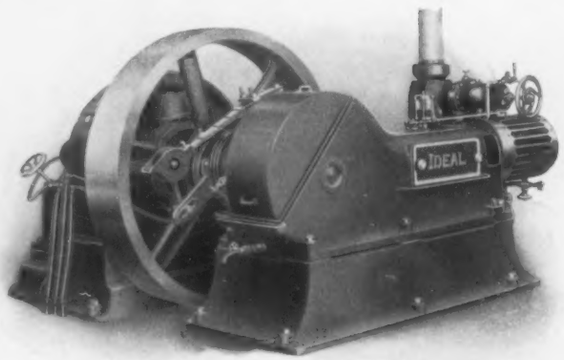
A highly sensitive, simple governor, in which the pins and bushings are relieved of pressure, thus reducing wear

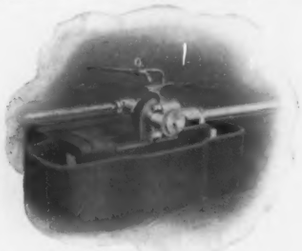
Cylindrical Valve

A symmetrical, cylindrical valve which will not twist or warp. A valve with large wearing surfaces, resulting in long life.



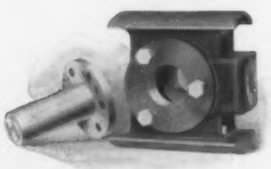
Submerged Slide

A silent valve slide which is entirely submerged in oil. Movements of parts through arcs is eliminated and the number of joints reduced.



Revolvable Pin

A heavy cylindrical cross head with a revolvable pin which remains cylindrical and can be removed without driving.



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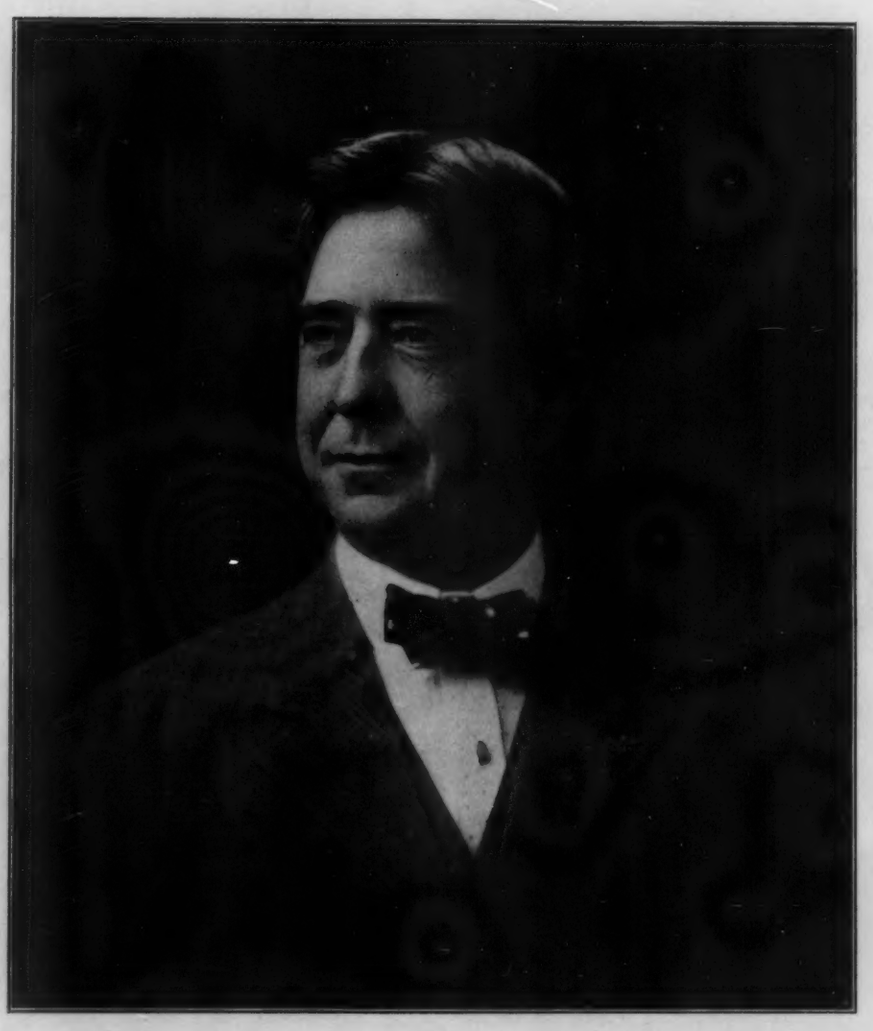

J. McMILLAN

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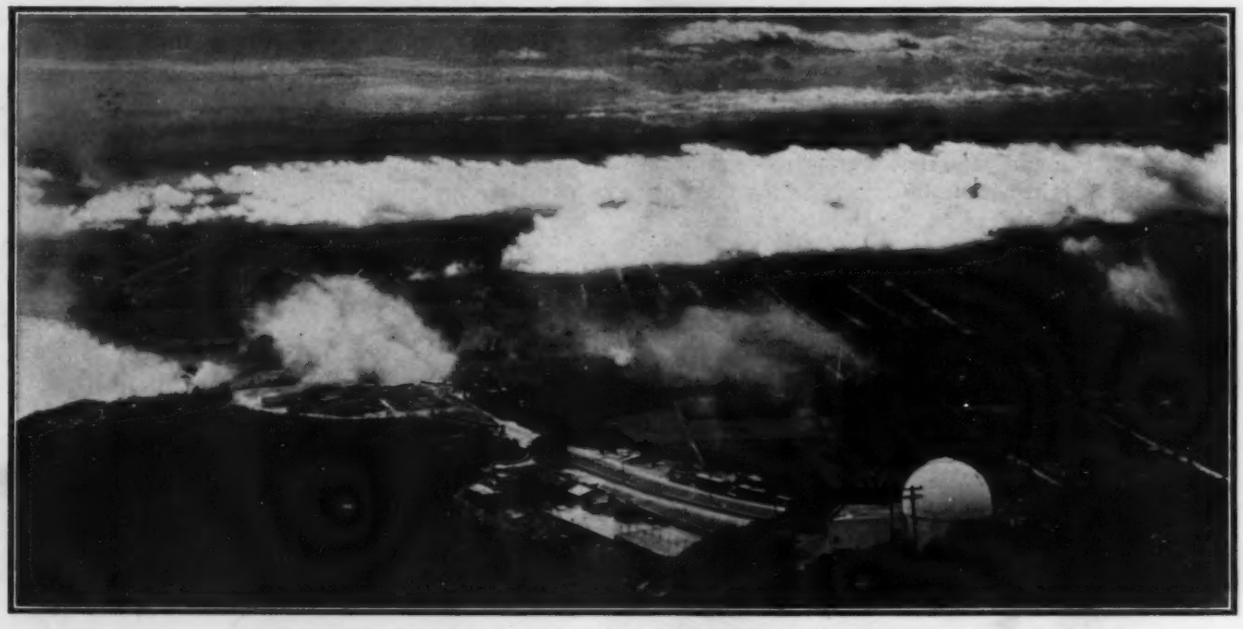
PACIFIC ELECTRIC RAILWAY INTERURBAN SYSTEM

By Rudolph W. Van Norden[1]

There are few places where Nature has gathered together so much for man's comfort and happiness and so little for his discontent or hardship as in the great and growing district surrounding the beautiful city of Los Angeles. Of her handiwork, there is bewildering variety, from mountains, bold, precipitous and picturesque, to valleys, broad, undulating and luxuriant in a riot of semi-tropical verdure, all to end abruptly in the limitless expanse of the blue Pacific with its gently sloping beaches interspersed with jagged bluffs and fantastic rock shores; the whole grouped to form panoramas to entrance the most prosaic mind. For the lover of outdoor life, Nature provides almost any climate desired, for the bracing air from the ocean is everpresent, any crop may be grown in the utmost profusion of quantity and of unsurpassed quality, and health or pleasure are always at command here, where the sun shines almost every day of the year, where the air is ever balmy and there are no winters.

That Los Angeles and the surrounding country is not only a great winter resort, but one of the greatest tourist centers in the world is well known, but few who have not lived there can appreciate the remarkable development which has taken place within a comparatively few years, or the highly efficient and modern institutions which have been provided for the convenience and comfort of native and visitor.



View of Echo Mountain and Pasadena From Mt. Lowe, Above the Clouds.

That the interurban system of electric railways centering in Los Angeles is the most perfect and complete in the world, is a statement often made by travelers of wide experience, and while there are many other well equipped and operated systems in the United States, it would be difficult to find the peer of the Pacific Electric, either in equipment or especially in method of operation. The motto, "speed, safety and comfort," is literally interpreted, while in equipment, the highest class of standard railway practice is followed. But the management and method of operation are, as in everything else, the ruling factors of success.

[1] Member Am. Inst. E. E., Am. Soc. C. E.

A Stretch of Main Line Parallelling the Huntington Drive.

Here the governing influence is like a happy family, all working as a harmonious whole for the maintenance of a system as perfect as genius and brains can accomplish.

The various departments are clear cut and well organized, many of the heads having been with the system since its inception. The whole is under the immediate supervision of the general manager, Mr. J. McMillan, to whose intimate knowledge of every movement in each department is largely due the remarkable harmony and high efficiency which has been reached in this system.

It would be hard to conceive of a more perfect distribution of routes to serve this territory of wonderful developments, than has been made in the building of this system, and yet, what is truly more remarkable, is the foresight of the designer, for the territory has been really developed as the result and following the completion of the various lines. Mr. Epes Randolph, who from 1900 to 1904 was first vice-president and general manager, laid his plans with the view of making the most complete and satisfactory interurban system in the world, by systematically creating the business to support it; and the care and judgment with which he carried out his desire and accomplished his purpose amid countless obstacles, is manifested in the results obtained and the acknowledgment and credit universally conceded.

The interurban system is divided into two main divisions under which are operated all but three of the lines. Of these three, two are operated in connection with the Los Angeles City division and the third, the Mt. Lowe line, is operated in conjunction with the Pasadena City division. The total trackage is about 600 miles.

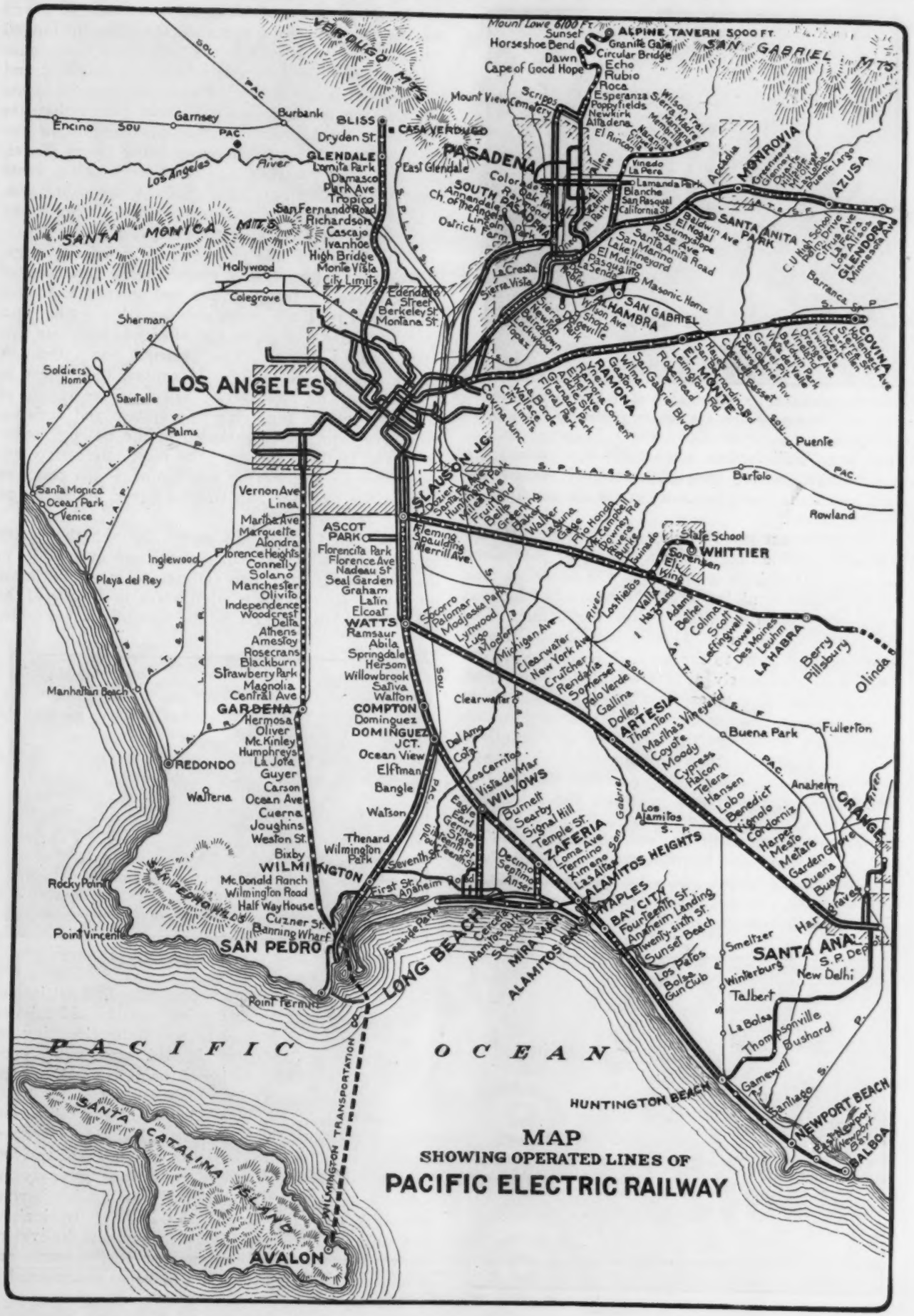
Each of the two main divisions, the Northern and Southern, are like great fans, or better, like a tree with its trunk and branches. The divisions meet and commence at the Pacific Electric building at Sixth and Main streets, in Los Angeles, and here is the main depot and the nucleus of the entire system, from which more trains are daily dispatched than from any five similar depots in the United States.

The Northern Division.

Trains on the Northern division, after leaving the depot, pass down Main street, through the business section of the city and, after crossing the Los Angeles river, take to the private right of way. This for a distance of three miles is double tracked as yet, due to the difficult route followed and the cost of construction, as it passes between hills and there were serious grades to overcome.

The right of way soon, however, spreads out and the four-track section commences near Eastlake Park, one of the many beautiful examples of landscape gardening, which show the possibilities of this section of California. At this point is also the junction of the Covina line. The four-track trunk line extends northeast for a distance of 6.5 miles, paralleling one of the principal suburban drives, the Huntington boulevard. The perfect roadbed, the symmetrical alignment of track and poles and the neatness and finish of the whole are at once the pride of the people and one of the show places of the district. At a distance of 7.42 miles from Los Angeles, another, the San Gabriel branch, meets the trunk line from the south. At Oneonta the branch over which is the heaviest traffic of this division, the short line to Pasadena, meets the

Junction of Pasadena Short Line with the Four-Track Trunk Line. Hotel Raymond in the Distance. The San Gabriel Range and Mt. Lowe in the Center Background Showing the Cable Incline and the Summit of Echo Mountain.


MAP
SHOWING OPERATED LINES OF
PACIFIC ELECTRIC RAILWAY
LOS ANGELES
PASADENA
SAN PEDRO
LONG BEACH
SANTA ANA
NEWPORT BEACH
HUNTINGTON BEACH
SAN GABRIEL
MONROVIA
AZUSA
GLENDORA
COVINA
EL MONTE
LA HABRA
WHITTIER
ORANGE
ANAHEIM
FULLERTON
BUENA PARK
ARTESIA
ZAFERIA
WILLOWS
COMPTON
GARDENA
WATTS
REDONDO
HERMOSA BEACH
MANHATTAN BEACH
SANTA MONICA
VENICE
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L. A. T. & S. L.
SOU. PAC.
Los Angeles River

Fine Example of Construction on Curve of Four-Track Line on the Northern Division.

trunk line. Still further, at Oak Knoll, a second line to Pasadena, passing through a recently settled district, leaves the main line and here is the terminus of the four tracks.

At a distance of 10.8 miles from Los Angeles the Sierra Madre line branches away from the continuing two-track line, which is known as the Glendora line.

Before the trunk line of the Northern division was built, there was in operation a third line between Los Angeles and Pasadena. This is now known as the "Old Line"; it turns to the north, leaving the present trunk line immediately after crossing the river and, following streets, reaches Pasadena by a somewhat devious course, passing en route the famous Ostrich Farm which almost everyone has seen or read about. From this line is a branch to Annandale, a suburb of beautiful homes. There is also a cross-country connection to the trunk line over which the Annandale cars operate.

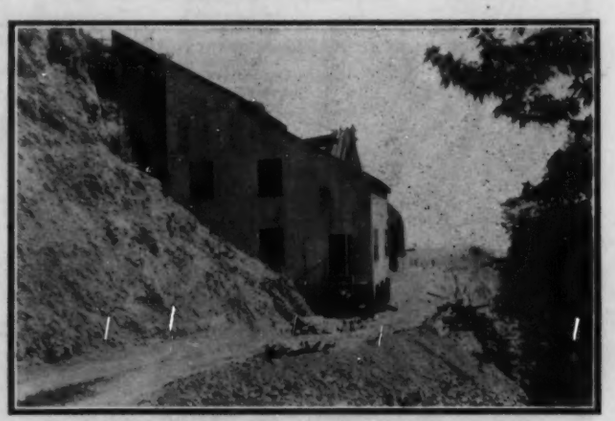
The Pasadena short line was the solution of the problem of rapid and frequent traffic between Pasadena and Los Angeles, while the Oak Knoll line, almost as quick, passes through the terraced properties of luxurious homes.

Street Scene in Pasadena.

Running east and west, just beyond the towns reached by these lines and abruptly rising in jagged pinnacles and precipices is the San Gabriel mountain range. Along its foot and among the foothills and spreading arroyas are nestled many picturesque towns and country residences. It is these places that are eventually reached by the various branches of the road, perhaps the most charming being Sierra Madre, at the foot of Mt. Wilson. The branch of the same name, after following gentle grades through orchards of countless fruit trees, passes through the town to the very foot of the government trail up Mt. Wilson.

The Glendora line parallels the mountain range, passing always through an everchanging panorama of orange groves, beautiful homes and prosperous towns, and back of it all the mountains furnish a setting in a countless variety of colors and effects to complete this fairy land of nature. The principal town through which this line is built is Monrovia, then there is Arcadia with its race track; Azusa, where is one of the power plants supplying this system and deriving its power from water gathered in the nearby mountains, and lastly Glendora. The most interesting feature, from an engineering standpoint, is the concrete arch bridge over the San Gabriel River, a description being given elsewhere.

The San Gabriel line passes through the pretty town of Alhambra to San Gabriel and eventually to the Masonic Home. San Gabriel, to many the most interesting spot on the whole system, is the site of the old mission, built in 1771 by the Spanish Padres under



Municipal Rock Crusher in San Dimas Canyon.

the leadership of Junipera Serra. The first settlement of the valley was at this point and the old mission church which has helped to make the charming romance of early California life, still remains in a good state of preservation, the joy of the native and wonderment and admiration of the visitor.

The branch to Covina takes an easterly direction, passing through much country which is as yet undeveloped. There are, however, a number of thriving towns, and wherever there are towns, one may see actually miles of orange orchards. This line is comparatively new, and has a section of single track about five miles long. As is the case throughout the system, the roadbed has been designed for double tracks and it will not be long before it will be so constructed in its entirety.

Oil Fields in the La Habra Valley.

At one point there is a long trestle crossing the San Gabriel River. To the casual observer the rivers in this normally dry country are a small factor in the landscape. But a storm in the mountains, such as is experienced on occasions during the winter months. may turn the dry arroya into a raging torrent, almost before one has had time to realize that a storm is on. Such was the action of the San Gabriel at one time, when, within one and a half hours, the water rose, leaving its bed for a new course a half mile to the east and took out 1000 feet of the roadbed fill. This was replaced by standard trestle so that there will be no danger of a repetition of the river's action.

The present terminus of this branch is at Covina, 23 miles from Los Angeles, but the road will be extended through San Dimas and eventually to Pomona. The road is now graded and finished past San Dimas and, through a spur, to the municipal rock crusher in the San Dimas canyon. Construction work on this section was expedited in order to get rock shipments.

Southern Division.

Trains for the Southern division pass through about a half mile of streets until the shops, car houses and freight yards are reached, when the private right of way is entered. This is the commencement of the four-track trunk from which the various diverting lines are taken.

The trunk, like that of the Northern division, is a magnificent example of electric railroad construction, straight as an arrow for a distance of 7.45 miles. The poles on either side of the right of way are, in alignment, as perfect as the track, a condition unfortunately not always maintained in the average American interurban railway. On the pole tops on both sides are carried double three-phase transmission lines, which at present carry the entire power supply for the system.

The four-track section now terminates at Watts.

Street Scene, Santa Ana.

Main Trunk Line, Slausen Tower and Whittier Branch.

beyond which place the standard two-track construction is maintained. But this is soon to be changed and the four tracks will extend 5.86 miles further to Dominguez Junction, famous for its aviation field.

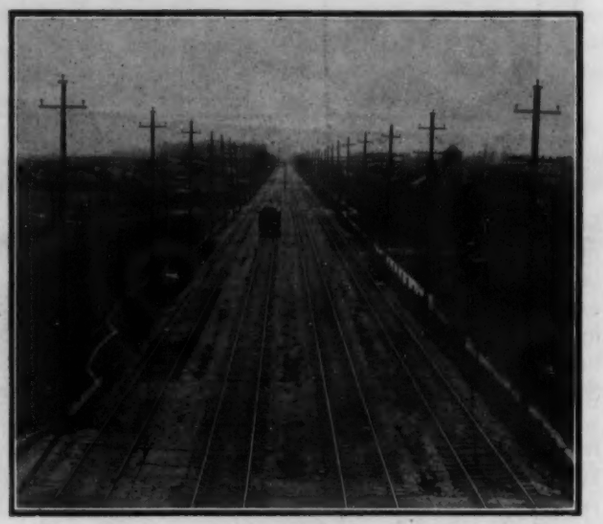
There are six feeders into the trunk line, respectively known as the Whittier, La Habra, Santa Ana, Newport, Long Beach and San Pedro harbor lines.

The Whittier line branches at Slauson Junction, a distance of 4.27 miles from the Los Angeles depot, and takes a southeasterly direction to Los Nietos Junction, whence it turns abruptly north, following a gentle grade into the city of Whittier. This is one of the beautiful towns reached, what was once an almost barren and desert waste is now a forest of citrus trees.

Heavy Cut on the La Habra Line.

palms and other semi-tropical growths, every inch of the rich soil being made to bear in luxuriant affluence.

The La Habra line is a continuation of the Whittier line from Los Nietos Junction, and is one of the newest sections of the road. It maintains the southeasterly direction, paralleling a low range of hills which lay to the north and which separates La Habra valley from San Gabriel valley. The original appearance of the section traversed at many points is yet in evidence and a trip over this line is an object lesson, not only of the vast possibilities of this wonderful country, but of the manner of the building of this system, first to build the railroad to bring settlers and thus cultivate and enhance land values and in turn to furnish a rapid and frequent communication between these points and the city. Crude petroleum in great quantities is found in these hills, and, at many places, there can be seen literally forests of oil derricks, all industriously pumping their share of California's liquid gold from mother earth.



Four-Track Trunk Line of the Southern Division.

Newport Beach.

The line is constructed throughout for two tracks, but for the time being much of it is single. Building operations are constantly extending the terminus, which is at the present time at Yorba Linda in San Bernardino county, a distance from Los Angeles of 29.75 miles. The universal high grade of construction

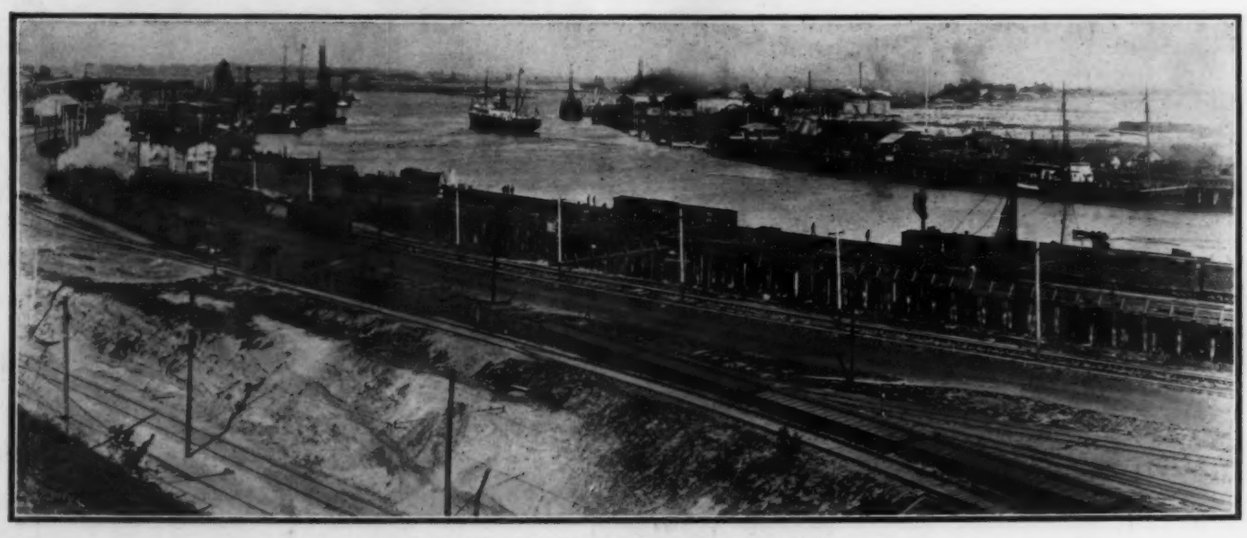
Government Breakwater, San Pedro Harbor.

An Afternoon Crowd at Long Beach.

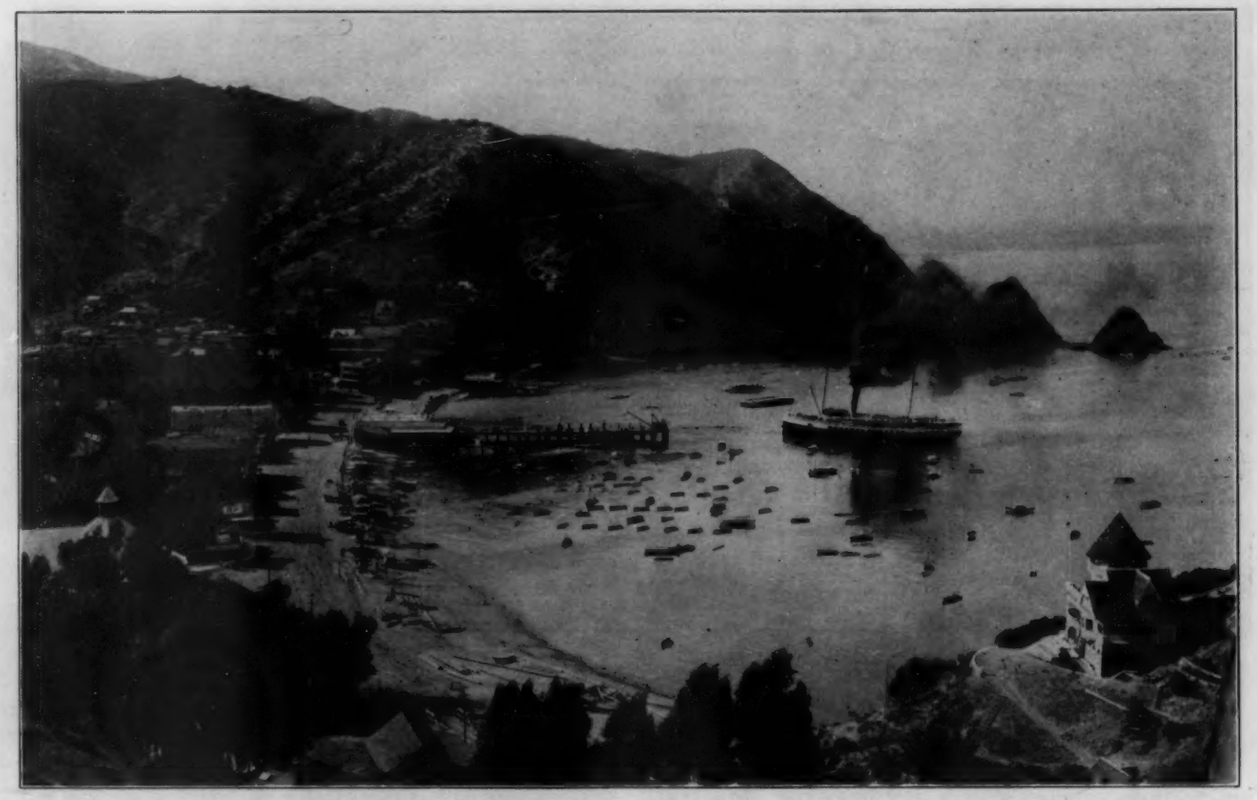
is maintained throughout, particularly noticeable being the long tangents, or straight sections.

The diversion of the Santa Ana line is at Watts. This section pursues also a southeasterly direction, passing through a flat and extremely fertile country a distance of 34 miles to the city of Santa Ana. Santa Ana is one of the larger cities reached by the system and is a place of homes and well shaded streets, with a modern, well built business section, evidencing on every hand the high average wealth of the community. From Santa Ana the road continues in a southerly direction to the ocean, a distance of 13.31 miles, where it joins the Newport branch at Huntington Beach. This section of line passes through a great sugar beet country and the freight traffic, hauling sugar beets to the refinery at Delhi and for shipment to foreign roads, is heavy. A noticeable feature are the many spurs with their loading platforms and inclined approaches. under which the cars are placed and from which the farmers dump their wagon loads of sugar beets.

The Newport and Long Beach lines branch at Dominguez Junction and take a southeasterly direction. The former line meets the ocean at Naples, and from this point to the terminus at Balboa is a charming trip where the track is almost washed by the breakers and where attention is no sooner attracted by the modern hotels, pretty cottages and the gay crowds on the beach of one resort than one is whisked to another and yet another. The most interesting feature in the construction of this line is the method of oiling the roadbed, which is largely of sand, to prevent it from being blown away. The road passes along the constantly shifting sand dunes, one day the sand drifting high against the rails and another perhaps blown clear of the ties, with the caprice of the wind. The rails therefore have cast joints, the ballast is laid level with the rail top and the whole thoroughly oiled to form a compact mass. This not only prevents blowing away or washing away in rain storms, but also prevents drifting of sand between the rails. The principal places



Pacific Electric Terminal, San Pedro Harbor.



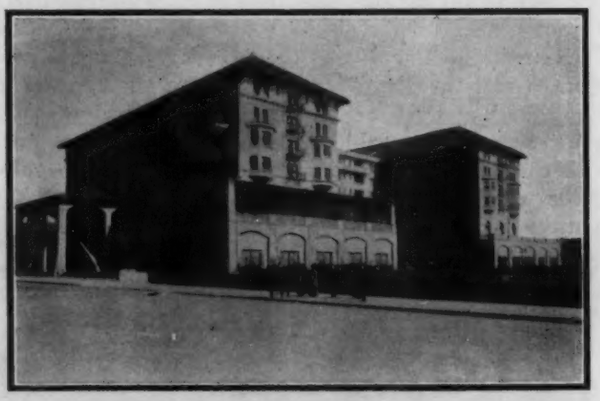
Avalon, Santa Catalina Island.

reached by this line are Naples, Anaheim Landing, Huntington Beach, Newport and Balboa.

The city of Long Beach, which is reached by a branch from the Newport line, is of recent and remarkable growth, the advent of the railroad having made possible this great playground. Like all of the other cities and suburbs, the streets are wide and clean, well shaded and lined with pretty and costly homes. The beach is, of course, the principal feature, and this, besides its long pier and the magnificent Hotel Virginia, is a maze of bath houses, restaurants and a thousand and one devices to amuse and entertain a pleasure-loving public. A fast 20-minute service between this place and Los Angeles is maintained throughout the year. The company also operates a service on the principal streets and there is a belt line to San Pedro.

The main line to San Pedro is a continuation of the trunk line. It enters a large freight and switching yard adjacent to the docks of the harbor, after crossing Wilmington bay on a trestle 1.5 miles long. The distance from Los Angeles to San Pedro is 22.68 miles.

San Pedro harbor is a "made" port, where, by the expenditure of many millions of dollars on the part of the United States Government and many more on the part of the people of Los Angeles, a great deep water



Hotel Virginia.

Long Trestle Across Wilmington Bay Near San Pedro.

Scene on the Glendale Line in the Hills North of Los Angeles.

harbor has been created. It is but one of the examples of the thrift and progressive spirit which universally prevails. And the city of Los Angeles by annexing a strip of land extending from the city proper to and including San Pedro and the harbor has made itself one of America's great seaport cities.

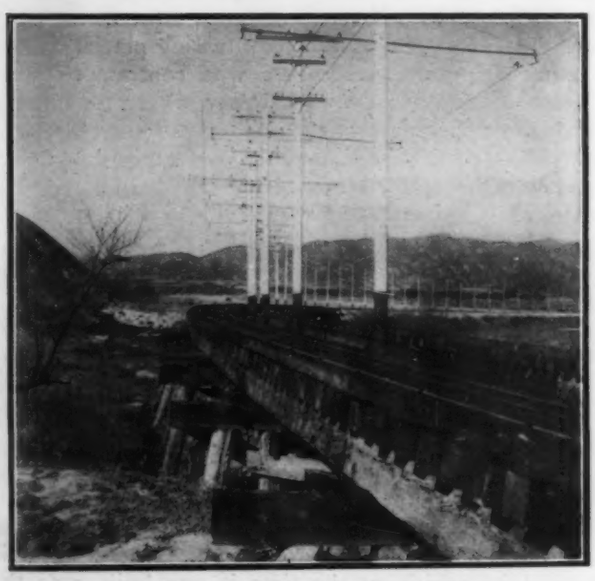
The passenger business to San Pedro is largely augmented by the boat connection at that point with Santa Catalina island, one of the loveliest all-year-round resorts in the world. This island is 30 miles off shore in the Pacific ocean, and is reached by regular steamers which leave upon the arrival of electric trains.

The City division will not be taken up in this article, except for the two interurban lines which are operated within its supervision. Trains for the Glendale line, after passing through the city, take a northerly course through the hills, north of the city, and crossing the San Fernando valley, through the growing and prosperous suburb of Glendale to the old Spanish hacienda of Casa Verdugo at the very base of the Verdugo mountains, a spur of the San Gabriel range. The remaining line is the "old" or Gardena narrow gauge, to San Pedro. This line after passing through the city, takes a southerly direction, passing through Gardena and a continuous stretch of fertile country and well-kept farms. This is one of the oldest lines of the system and will eventually be made to standard gauge. The cars of this line do not leave and arrive at the main depot at Los Angeles, as there is no provision there for narrow-gauge trains.

Mt. Lowe Line.

The Pasadena city section of the system includes the famous line up Mt. Lowe to Alpine Tavern. This

Pier at Long Beach.



Trestle and Scene on the Glendale Line.

enterprise was conceived and built by Prof. T. S. C. Lowe, who also built the astronomical observatory on Echo mountain. His plan was thought, at the time, to be a wild fancy, but he succeeded after many hardships in carrying out his ideas and the trip is always one of the first taken by the tourist.

The Pasadena system extends through Altadena and follows a winding course into Rubio Canyon, one of the many rugged and picturesque canyons of the San Gabriel range. In Rubio Canyon is a large depot platform and waiting room from which the world-famed inclined road takes a straight course up the canyon side to the crest of Echo mountain.

The length of the incline is 2581 ft., and the rise is 1238 ft. The slant with the horizontal averages 29 degrees, although at one point it is 32 degrees or 62 per cent. There are three rails with a passing switch at the middle point and two cars are operated together, being fastened to either end of a 1¼-in. cable, one going up as the other descends, passing each other at the switch. There is a stationary cable which lies under the center of each car and which may be gripped by an automatic device for safety.

"Ye Alpine Tavern." Terminus of Line on Mt. Lowe.

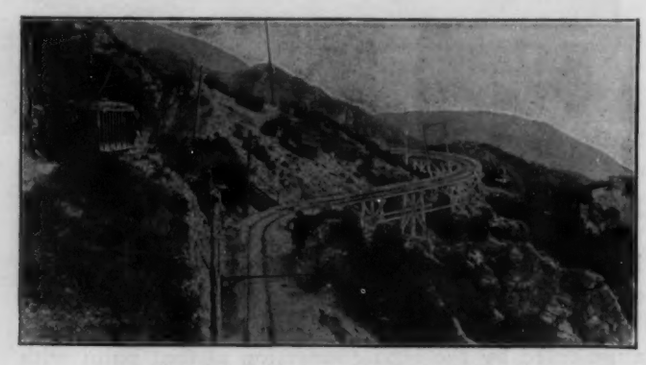
The operating house at the top of the incline, is a substantial concrete building containing platforms and waiting rooms for passengers who continue further. The cable operator sits in a tower where he can observe the upper part of the incline. Before him is a control board with instruments, rheostat and switches operating the motor which drives the cable, and also an ingenious device to indicate the exact position of the cars at any moment.

The operating mechanism in the basement of the building is driven by a 100-h.p., 500-volt, shunt, Westinghouse motor. It has both hand and band brakes and drives the large inclined cable wheel through spur and bevel gearing. This wheel is equipped with Halliday grips, which are a double set of steel fingers around the periphery, and which automatically grip the cable as it touches the rim of the wheel and loosen their hold when the cable leaves the wheel. No slipping is possible with this device. Mounted on the roof of the building is the great 60-in. General Electric searchlight, which, at the time it was built, was the largest and most powerful in existence and will be remembered for its famous service on the Manufacturers and Liberal Arts building at the World's Fair at Chicago in 1893.

From this point to the Alpine Tavern the road is of ordinary construction with trolley, the gauge being 3 ft. Many ingenious and difficult pieces of engineering are in evidence, especially the circular bridge which was necessary to gain a certain elevation and yet preserve the grade adopted.

All of the engineering work of the system is under the general supervision of the chief engineer, Mr. Geo. E. Pillsbury, who has been associated with the system since its inception.

The ride from Echo mountain to the Alpine Tavern for scenic beauty and grandeur defies description. The passenger has before him a panorama over the San Gabriel and San Fernando valleys, the city of Pasadena at his feet, Los Angeles in the distance and yet further the broad expanse of the Pacific ocean. If the day be clear, as most days are in this land of sunshine, he can see Santa Catalina island and even San Clemente island, some 30 miles beyond. The distance from Echo mountain to the Alpine Tavern is 3.57 miles. In winter the passenger, in the space of an hour, may travel from Pasadena, where a frost is scarcely known, into snow and ice and at times above the clouds enveloping the valley, thus getting a variety of climate and scenery, within a short space of time, unheard of in any other locality.

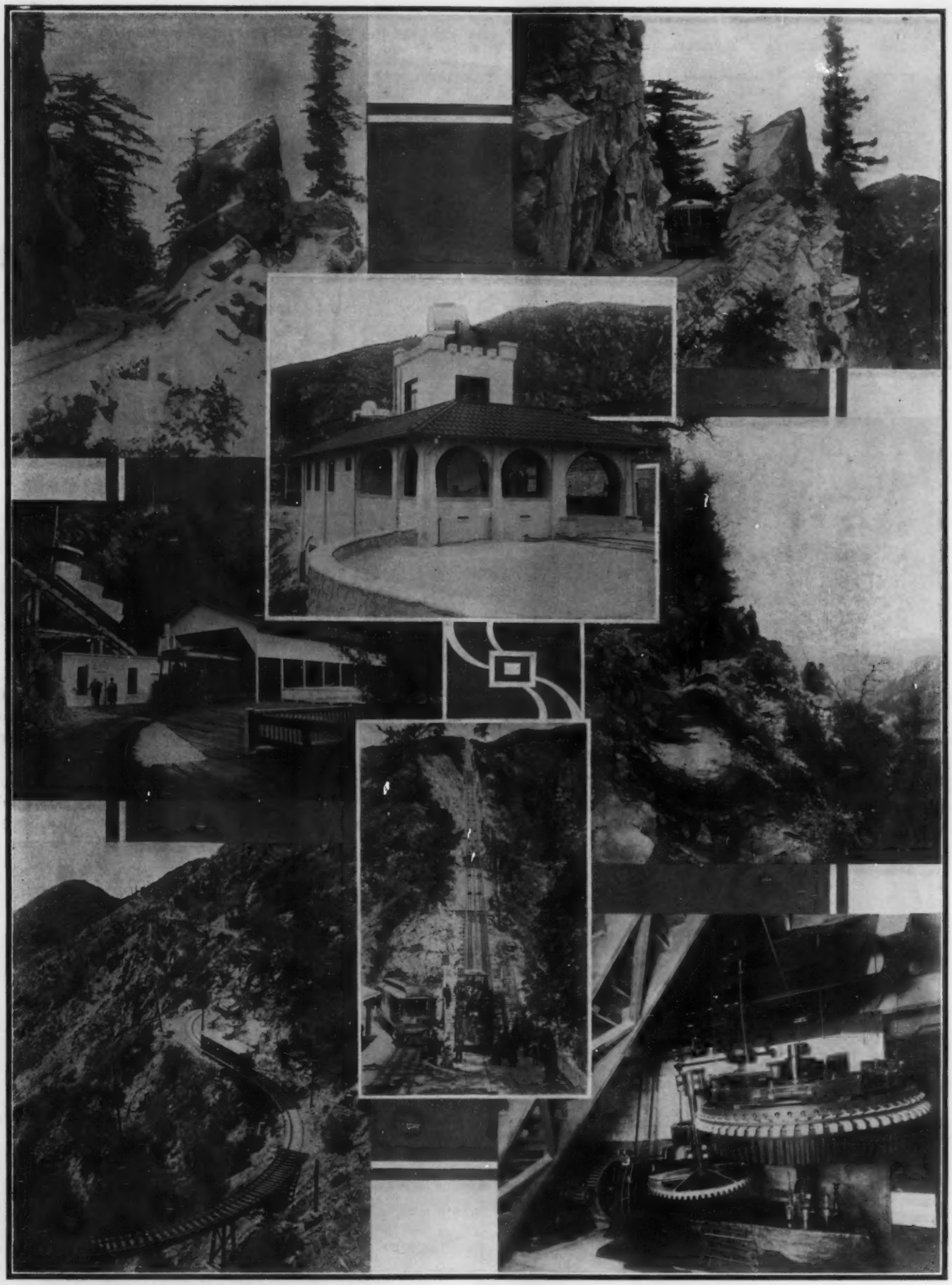


Circular Bridge on Mt. Lowe Line.

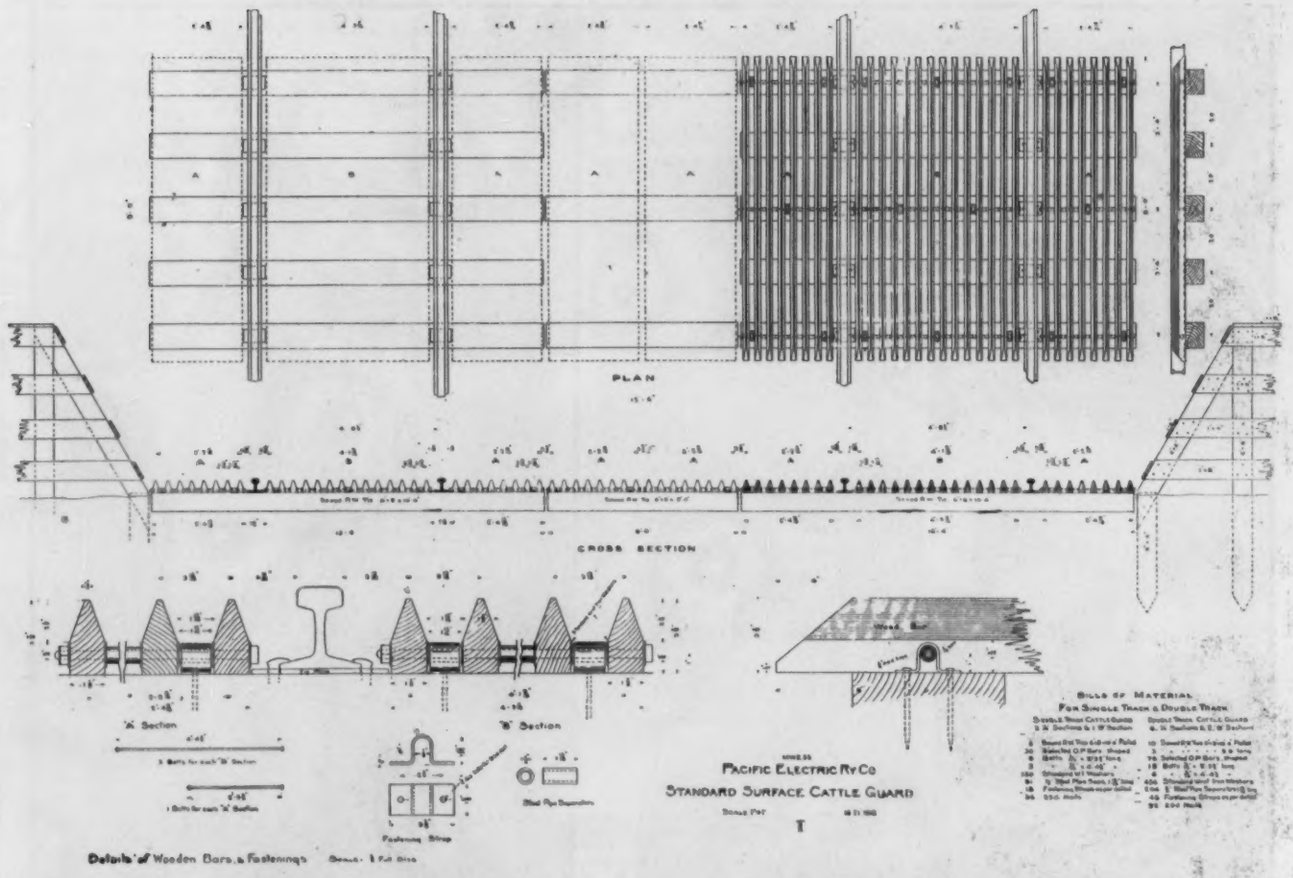
Track and Roadbed.

In the design and maintenance of the track and roadbed, standard American steam railway practice is followed. This company has, however, always made it a matter of policy to make all equipment and construction somewhat stronger and heavier than is called for in the service requirements. In other words, the element of lowest first cost is not strictly adhered to, as is unfortunately the case in many of our railroads, but on the contrary the least chance of interruption and therefore the highest class of work and materials is the principal aim.

The interurban lines are uniformly equipped with 70-lb., A. S. C. E. profile rails, although within cities and some towns, 6-in., 72-lb., Loraine section is used and also some 7¼-in., 87-lb. rail. Standard continuous rail joints are almost universally used, although on some lines, where the drifting of sand is often liable



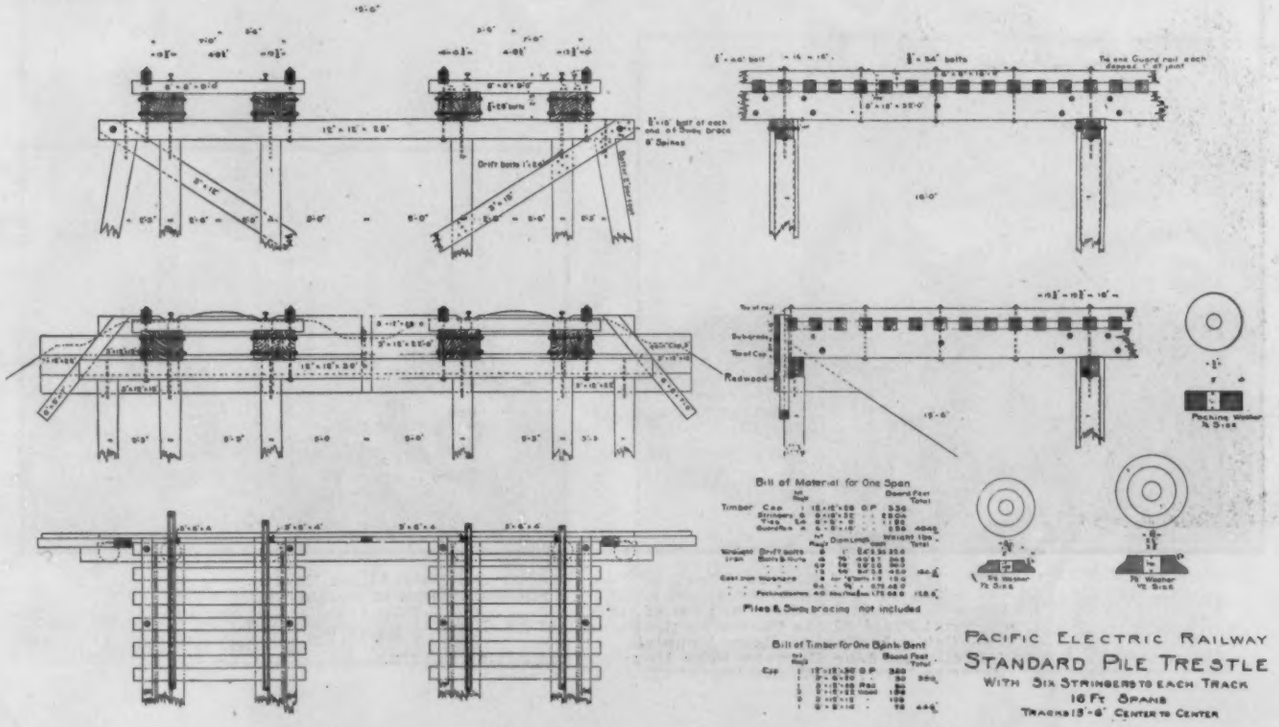
1 and 2. Winter and Summer Views of Deep Granite Cut Near Alpine Tavern.
3. Cable Operating House and Depot at Echo Mountain, Summit of Incline.
4. Train Shed in Rubio Canyon, Foot of Incline.
5. On Trail From Alpine Tavern to the Summit of Mt. Lowe.
6. The Cable Incline to Echo Mountain.
7. A Section of Line Between Echo Mountain and Alpine Tavern.
8. Motor and Driving Mechanism of the Cable Incline.



to cover the track, cast joints are employed. Switches, crossovers and turnouts follow standard steam practice.

The life of cross ties on different points of the system varies widely due to the nature of soils. At some points alkali deposits will rapidly decay the wood, and pine ties will not last more than two or three years at most, while redwood will remain intact for eight to ten years. Split redwood has been largely used for this reason. None of the ties are chemically treated before laying. The ties are 6 in. x 8 in. x 8 ft.

Gravel ballast is used to a great extent. This is easily procurable from the several gravel pits operated in connection with the system. On some of the lines,


Bill of Material for One Span
Piles & Sway bracing not included
Bill of Timber for One Bents Bent
Pacific Electric Railway
Standard Pile Trestle
With Six Stringers to each Track
16 Ft. Spans
Tracks 13'-6" Center to Center

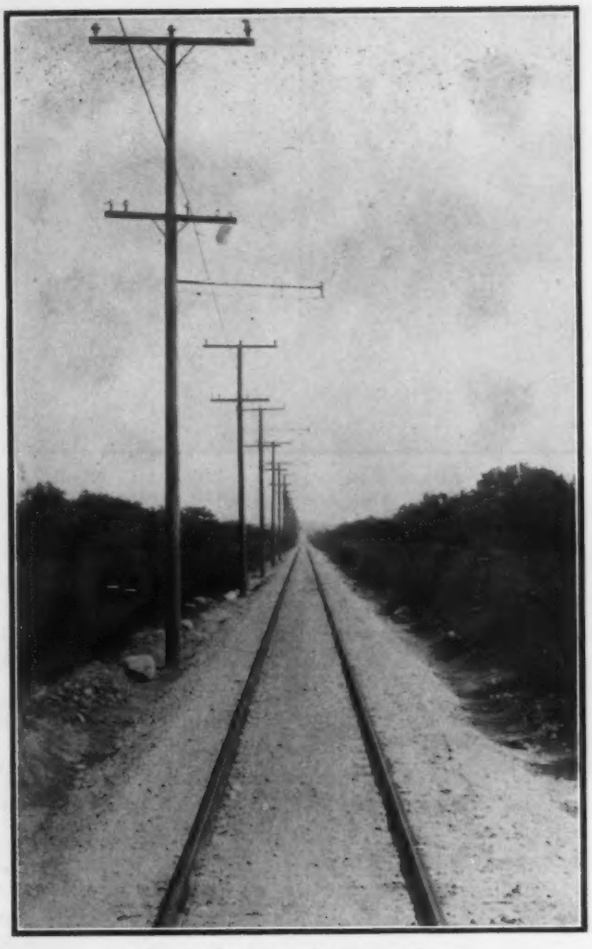
where gravel is not so easily procured and where the roadbed is adobe, loam, or sand, oiling has been resorted to. This makes a compact ballast, prevents the formation of dust during the summer months and sheds water during the rainy season. On the Huntington Beach line, where sand during a hard blow from the ocean can quickly fill up the space between rails, the special precautions already described to prevent the ballast blowing away and the drifting of sand against the rails is employed.

The oil used is from the Sunset district and is known as Sunset road oil. It contains 75 to 80 per cent of asphalt. It is applied once a year from a special car. This car, an ordinary flat, is equipped with a sprinkler outfit from which the oil is distributed after having been heated by steam coils supplied from a small boiler also on the car. Where the distance is not too great, it is found to be more satisfactory to heat the oil from the steam supply at the car shops and then haul the sprinkler to the section to be treated. A road roller is also carried on the car, so arranged that it may be quickly run off at a road crossing or other place where rolling or quick finishing is necessary.

A standard simple cattle guard has been adopted, shown in the accompanying drawing, composed of strips of wood. Pit guards have been entirely done away with as being dangerous and causing more trouble than they avoided.

In all two-track work the centers are 15 ft. 6 in. apart; while on the four-track sections, the two outside tracks are placed with 13 ft. 6 in. centers to adjoining tracks.

Throughout the system, brazed bonds are used. They are 11 in. long and have an area of 300,000 cir. mils. The brazing is done by a bonding car furnished by the Electric Railway Improvement Company of Cleveland, O. This little car is equipped with a 30-kw. rotary-converter set which delivers alternating current at 370 volts to a transformer which in turn delivers a heavy current at a potential of 4 volts to the brazing electrodes or terminals.



Gravel Roadbed, La Habra Line.

A standard form of trestle is used on all parts of the system where rivers, washes or ditches are crossed. This is well shown in the illustrations. As a rule 30 ft. piles are used and the average cost of double-track construction is $14 per ft.

There is, near Azusa on the Glendora line, a concrete trestle over the San Gabriel river, interesting on

Trestle on the Whittier-La Habra Line.

Example of Oiled Roadbed on Whittier Line.

Mexican Laborers Laying and Grading New Track at San Dimas.

Making Repairs to Trolley on Four-Track Line.

account of its size. This trestle carries two tracks and is made up of a series of 18 arches, each having a span of 50 ft. The rise of the arch is 8 ft. 10 in., and the thickness at the crown is 22 in. The total length is 1025 ft., and the cost is estimated to have been $132 per ft.

Labor for the roadbed and right of way is done largely by Mexicans. These men are ignorant, as a rule, and must learn their duties from the ground up. They soon become proficient and take great interest in their work. Many of them own their tools and a Mexican, once he has earned enough to buy these, will care for them and guard them as jealously as he would his own child. They are eager and dependable and appreciate the universally good treatment accorded them by the company.

There are a number of large gravel pits on the Glendora line, one on the Sierra Madre line and one on the Covina line. There are five crusher plants at as many of the pits and in others steam shovels are used in loading cars. In the San Dimas canyon, about five miles back of the town of that name, is the large municipal crushing plant. An extension of the Covina line has been completed to this plant and it is estimated that about 50 cars of crushed rock for both municipal purposes and for public sale will be hauled out every day.

Where ditches and water courses are crossed, if they are small enough to require only a culvert and not a trestle, reinforced concrete pipe is laid through the embankment. This pipe is 24 in. and 30 in. diameter, as the requirement may be.

Overhead Construction.

The manner of supplying electric current to the cars of this system has been much discussed among

Electrically Operated Plant at Slauson, Showing Tower, Bridges and Switch-Operating Motors.

engineers. The overhead trolley was, however, definitely decided on early in its history, and if results are any criterion the wisdom and judgment of the engineers has been well justified.

While practically all lines are on private right of way, much of the trackage is within cities and towns, and where this is not the case, the numerous road crossings would break the continuity of a third-rail system.

Trolley construction has been well standardized in all details, which is undoubtedly one of the contributing causes to the maintenance of the superb alignment and uniformity, although this is more directly due to the close attention to details by the engineer in charge and the perfect understanding and system of intercommunication between the various departments maintained by the management.

A single pole construction has been adopted uniformly, except where four tracks are operated. The construction for single and double track is the same, as it is assumed that any stretch of single track will eventually be double tracked.

The poles are round Washington cedar, 40 ft. long, and are placed between the tracks, 7 ft. 9 in. from the center of either.

A simple pipe bracket of 1½-in. standard wrought iron pipe and 9 ft. long extends from either side of the pole, at a height of 21 ft. above the top of the rail. This bracket is braced by a 5/16-in. steel strand fastened between the pole and a malleable casting which terminates the pipe arm. The trolley insulator and wire is supported from a second 5/16-in. steel strand parallel to and underneath the pipe arm, fastened at one end to the pole, at the other to the malleable casting and supported at the middle from the arm.

The trolley wire is 000 standard grooved copper, there being about 400 miles of this wire in place. There has been a small amount, about 25 miles, of No. 0000 figure eight wire in use. This latter proved unsatisfactory for high speed work. The lower part being heavier, the upper part would stretch, causing a bend or wave which would run along the wire to a flaw and then the wire would break. This wire has been replaced by 000 grooved phono-electric, which is now used for all new high speed work.

On curves the construction is the same and the poles are given a top offset up to 18 in., depending on the superelevation of the track. There are a few examples, on curves of short radius, where two lines of poles are used, set outside of the tracks, but this construction is avoided if possible.

Above the trolley brackets is a cross-arm which carries on one side two and in some cases four telephone wires. These are No. 12 copper and are used entirely for the operation of trains. On the other side the trolley feeders are carried. The top of the pole invariably carries one and, in a few sections, two three-wire copper circuits for the 15,000-volt substation distribution.

On the two four-track sections, two lines of poles are set on either side, outside of the tracks. These poles are nearly all 50 ft. long and are given a top offset of 3 ft. The trolley wires are supported in the ordinary manner, but in order to hold the two inside trolleys in line with the others an auxiliary wire is fastened to the main support wire in such a manner that the strain at the center of the latter is carried by the former. There is also fastened from pole to pole, on curves, a messenger wire and from this is stretched across the tracks, additional trolley wire supports. This system insures the trolley wires from displacement and undue vibration where high train speeds are maintained.

The poles on tangents on both the two and four-track construction are spaced about 110 ft. apart. On curves on the four-track lines, the inside line of poles are spaced 95 ft., while the outside line are spaced 50 ft. apart.

Pole-Setting Specification.

	in.	in.	in.	in.	in.	in.	in.	in.	in.	in.	in.	in.
A	½	1	1½	2	2½	3	3½	4	4½	5	5½	6
B	2⅛	4¼	6⅜	8½	10⅝	12¾	14⅞	17	19⅛	21¼	23⅜	25½
C	2⅛	4¼	6⅜	8½	10⅝	12¾	14⅞	17	19⅛	21¼	23⅜	25½
D	1½	3	4½	6	7½	9	10½	12	13½	15	16½	18
	ft.in.	ft.in.	ft.in.	ft.in.	ft.in.	ft.in.	ft.in.	ft.in.	ft.in.	ft.in.	ft.in.	ft.in.
E	11-6½	11-7	11-7½	11-8	11-8½	11-9	11-9½	11-10	11-10½	11-11	11-11½	12-0
F	10-5½	10-5	10-4½	10-4	10-3½	10-3	10-2½	10-2	10-1½	10-1	10-½	10-0

A. Superelevation.
B. Offset of trolley.
C. Rake of pole, single pole construction.
D. Offset of pole, single pole construction.
E. and F. Dimensions for framing pipe arms for curves.

Signal System and Interlocking Plants.

The extensive signal equipment in use and to be installed is a necessary adjunct towards the safety and rapidity of movement of the unusually heavy traffic handled. The system is operated by a department for that exclusive service under the supervision of Mr. A. E. Roome. As before stated, dispatching trains and

Electrically-Operated Interlocking Tower at Amoco Junction.

all communication between the main depot and every part of the system is by telephone.

All block signal and station semaphores are manually operated by the station attendants. But at junction points with steam railroads, signal towers are maintained which are either manually or electrically operated. By this means absolute safety at crossings is assured and, at the same time, high speeds are maintained, which, were it not for these towers, would make the frequent and rapid schedules impossible.

An automatic electric block system is to be installed on the four-track trunk line of the Northern

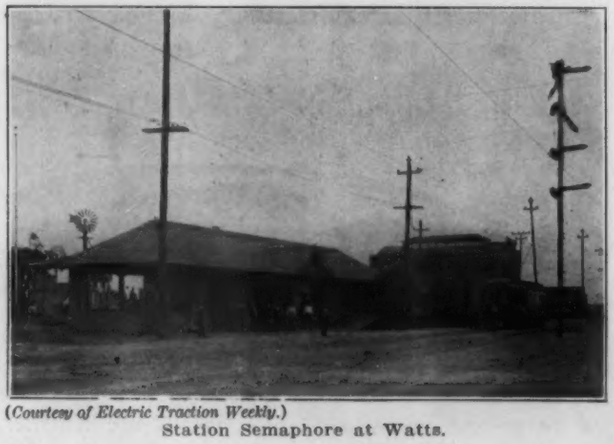
(*Courtesy of Electric Traction Weekly.*)
Interlocking Plant at Dominguez Junction, Substation on the Right.

division. This is deemed necessary, due to the heavy traffic, as trains are not allowed to run closer than one-half mile and there is little leeway in maintaining

(*Courtesy of Electric Traction Weekly.*)
Interior of Slausen Tower, Showing Levers and Interlockers.

this distance where trains during parts of the day pass a given point at intervals of 45 seconds.

Two of the interlocking junction towers, established several years ago, are mechanically operated,



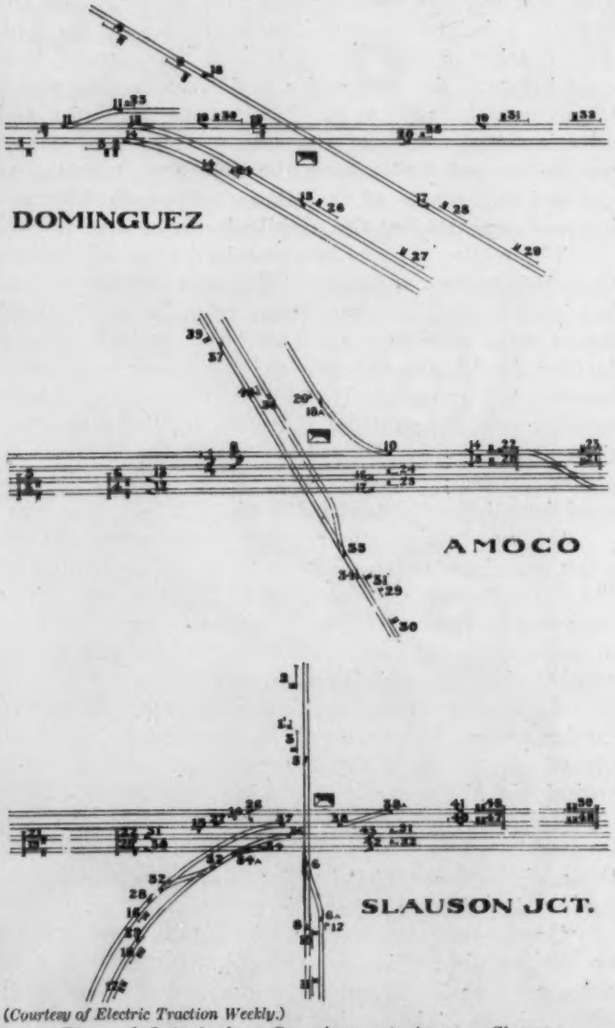
(*Courtesy of Electric Traction Weekly.*)
Station Semaphore at Watts.

the equipment having been furnished by the Union Switch & Signal Company. One is at Dominguez Junction, where the Long Beach and Newport lines leave the trunk, and the line to San Pedro at the crossing with the Southern Pacific Railway. It is, like all of the towers, a two-story frame building, 12 ft. by 12 ft., and follows a standard design. There are 175 regular electric and 12 steam trains handled daily. The operating levers on the second floor are 28 in number.

The other mechanical plant is at Oneonta Junction. This plant is similar in equipment with the Dominguez plant and handles 185 electric and 12 steam trains daily.

The electrically operated towers have been recently installed and were furnished by the General Railway Signal Company. There are at present two in operation, although three more are under contemplation. These towers are at Amoco Junction, where the Southern Pacific Railway crosses the four-track trunk of the Southern division, and at Slauson Junction, where the Santa Fe Railway also crosses the four-track line. The Whittier and La Habra line also joins the trunk lines at this latter point.

These towers are interesting from the fact that they not only represent modern practice, but also on



(*Courtesy of Electric Traction Weekly.*)
Plan of Interlocker Crossings at Amoco, Slausen Junction and Dominguez.

account of the great number of train movements which they control. The Amoco tower is equipped with 40 and the Slauson with 50 levers. The latter tower is the most intricate and has the greatest number of train movements. It handles 288 through and 172 local electric, regular passenger and 12 steam trains daily. The average number of movements per day is 1840.

In the first floor of the towers are the storage batteries for operating the motors which actuate the various signals and switches. On the upper floor are the operating levers, interlocking cabinet and the switchboard. At the Slauson plant, there are 9 swich operating levers, 13 on the derailers, 14 which operate 19 high signals and 7 operating dwarf signals.

Four lever movements are made in passing a train. Both home and distant signals are mounted on bridges, the signals being over the centers of the respective tracks. The distant signals are 1200 ft. while the others are 500 ft. from the tower; the derailing switches are 55 ft. beyond the home signals. The operator's first lever movement closes the derailing switch, the second locks this switch, the third movement clears the home signal and the fourth clears the distant signal, which also locks all conflicting tracks and locks their derailers open.

The movements of all switches and signals are actuated by motors, one being required for each movement. The switch motors are in cast iron housings at the side of the track, while those for the semaphores are in the base of the tower or on the bridge, as the case may be.

The storage battery in the base of the tower consists of 55 chloride cells, having a capacity of 80

Form PE-SM-3-08

Pacific Electric Railway Co.

REPORT OF CONDITION OF INTERLOCKING PLANT

Name of Plant Oniota Tower

Initials of Foreign Roads (if any)

Date 1-31 1909 Time Covered by Report 6 P. M. To 6 A. M.

The following questions must be answered by erasing "Yes" for a negative and "No" for an affirmative reply. All defects in plant, delays to trains, disregard of rules or other irregularities must be reported fully under "Remarks" and by letter accompanying report if necessary.

1. Did you read Report of Signalman relieved by you and understand condition of plant before going on duty?	Yes	7. Are all Signals properly adjusted for both position?	Yes No
2. Is there any evidence of looseness or failure in machine or locking?	No	8. Are all Signal glasses and lenses clean and uninjured?	Yes No
3. Is there any evidence of looseness or failure in lead out or outside connections?	No	9. Have any Signal lamps gone out during the night?	No Yes
4. Are any Crank, Compensator, Wheel, or other foundations loose?	No	10. Are all electric attachments working properly? (If any).	Yes No
5. Do all switches and derails lock properly?	Yes	11. Has there been any disregard of the rules by trainmen or others?	No Yes
6. Are all detector bars working and in good adjustment for both positions?	Yes	12. Have any trains been delayed?	No Yes

Date of last inspection by Signal Maintainer 1-28-09

Date of last inspection by Foreign Road (if any) 1-28-09

REMARKS

Lock #31 went out of order at 6 2 P.M. also distant signal north bound main line failed to come back to position.

Correct C C Dodge Day Operator

Received Report 6 30 P.M.

Signalman P Binnicker

Defects Repaired 7 04 A.M.

J. A. Barham Signal Maintainer.

While on duty each day and night Signalman must carefully inspect plant and at the end of each shift fill out two of these Reports, show them to the man relieving him (who will note any effects before taking charge) and then mail one to Superintendent of Division and one to Signal Engineer by first train.

(Courtesy of Electric Traction Weekly.)

Report of Condition of Interlocking Plant.

Automatic Crossing Flagman.

ampere hours. The maximum charging current is 10 amperes which is taken from the trolley after passing through a suitable resistance. Ordinarily the battery is floating on the supply current and there is a continuous charge of about 2 amperes. The cost of charging per month is insignificant, amounting to about $1.50.

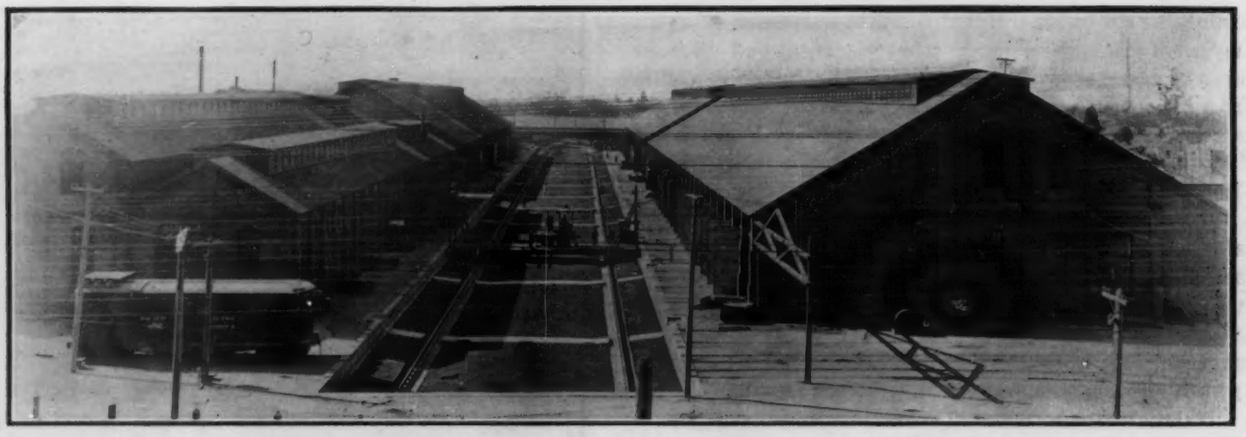
The interlocking control is so arranged that it is impossible for the operator to make a false move and permit two trains to approach a crossing at the same time. The bed on the surface of the machine is intricate, being composed of 2593 pieces.

All lines and apparatus are amply protected by lightning arresters and fuses. Four 1-c.p., 27½-volt lamps are placed in each signal circuit, one of them being a pilot lamp in the tower, while the other three are in the signal. Mounted in front of the signal lamps are lenses which make the light visible for 2 miles.

The lights and power operations are governed from a switchboard, by 30 switches, and it is equipped with voltmeters, ammeters and ground detectors, also the pilot light for each circuit.

The slightest derangement of the switches or circuits will block operation and should a switch point be jarred or pried open a small fraction of an inch the signals will not clear until the fault is remedied.

A most thorough and careful system of inspection is followed; this is made by both signalmen at the end of their shifts, who fill out a report form in duplicate noting any defects or irregularities and is signed by both men. These are immediately sent to the division superintendent and the signal engineer. Inspection is made once a week by the foreman of the department and every other week by the superintendent, while every 30 days the inspector of the steam road at the point in question is called in for a joint inspection.



Car Shops at Los Angeles.

Swinging Signals.

A novelty which this system has recently placed in use, and will be installed at all road crossings, is a moving signal or automatic flagman. This signal, seen in the illustration, consists of the familiar continuous striking gong, but mounted above the gong is a forked arm, standing when at rest in a vertical position. This arm is swung from its middle on trunnions; at the top is a large hollow disc, painted so as to be conspicuous, the center of the disc having on both sides a circular opening, and within the disc is a red electric light; while at the bottom is a weight acting as a pendulum. Upon the approach of a train, the signal actuated through track contact commences to swing, the disc moving back and forth while the gong rings in unison with the movement, the light in the disc shows and a series of five lamps also lights, illuminating the crossing. Current from the trolley lights the lamps and also after passing through a resistance operates a 1/12-h.p. motor which actuates the swinging arm.

There will be several additional electric interlocking towers at steam railroad crossings. A new electric interlocking tower is under process of construction where the Pasadena short line leaves the four-track trunk, at Oneonta Park. This will be equal in size to the Slauson tower.

Car Houses and Shops.

At Los Angeles, close to the car shops, are the main car houses. Most of the interurban cars are stored here, the buildings having a capacity for 100 cars. The illustration gives a good idea of the size and capacity. At Pasadena are two car houses, both of them substantial brick structures. One of these is in the building of the old steam plant, now abandoned, but recently converted into a substation. It is used to store interurban cars. The other is larger and used for city cars. At Long Beach is a new substantial brick car house with a capacity for 25 cars.

This company has not, for various reasons, built any of its new car bodies. The repairing and reconstruction of cars is, however, a necessary adjunct and this work is done by the mechanical engineering department, of which Mr. F. F. Small is superintendent, in the extensive and well equipped shops at Los Angeles.

These shops are arranged in two principal rows between which is a transfer table operating the entire length. One feature of the environment that is forcibly impressed upon the casual observer, a feature which is consistently carried out with the system, is the neat and cleanly appearance, both within and without the buildings, the absence of junk piles and the air of cheerfulness imparted by the lawn and terraces within the transfer runway.

Car Houses and Storage Tracks at Los Angeles.

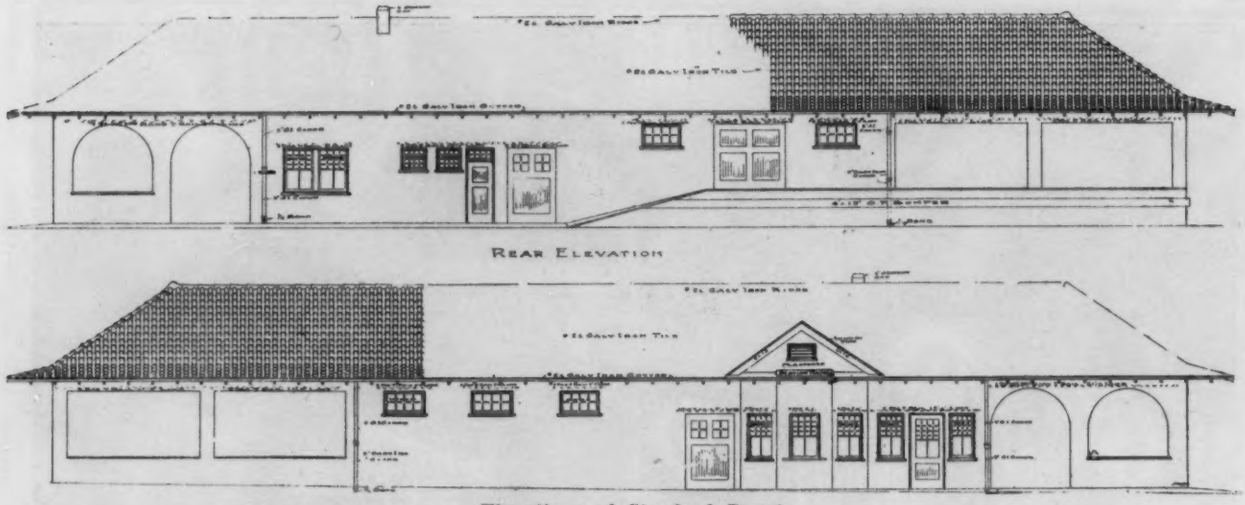
Views in Car Shops: 1—Winding Armatures; 2—Car Repair Shop; 3—Forming Armature Coils; 4—Overhauled Motors Ready for Mounting; 5—Cabinet Shop; 6—Paint Shop; 7—Machine Shop; 8—Forge Shop

Within the buildings on the right of the view shown are the general repair and assembly departments. On the left is a well equipped machine shop with motor driven tools. To the rear of this shop is the forge shop. Beyond is the paint shop and adjacent to it the storeroom building over which is the cabinet and carpenter shop.

Many parts of the rolling stock equipment have been designed and built here and these designs have been adopted as standard for the system. This is true of car trucks, of which a number of styles are built, depending upon the equipment.

One of the most interesting departments is the motor and armature winding shop. Here all work of this nature is carefully and thoroughly accomplished.

The Greenameyer pneumatic trolley used on all cars, and now in more or less general use, was invented and designed in these shops and is built here. It displaces the various spring arrangements used elsewhere and is actuated by compressed air from the

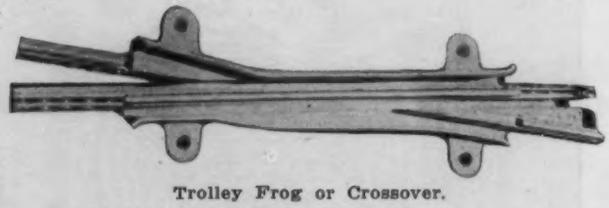


Elevations of Standard Depot.

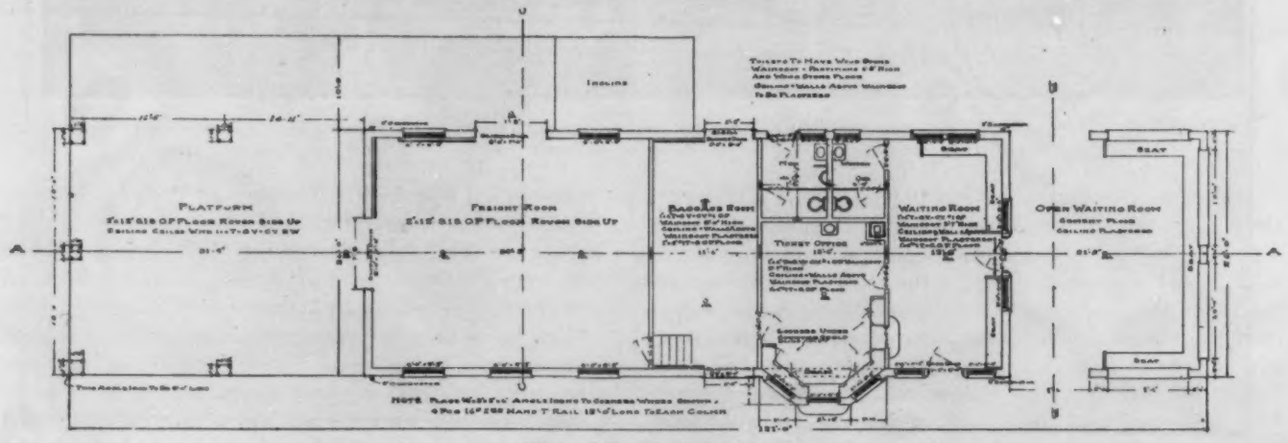
car reservoir. The base of the trolley pole is pivoted and the pole tends to assume a vertical position through the strain of a spiral spring actuating the bell crank at its lower end. Two cylinders mounted together and supported on trunnions serve to control the motion of the trolley should it leave the wire. The plungers in these cylinders also connected together, are pivoted to a cast arm on the pole. Air is brought through the swivel base to the lower end of the large cylinder, thus assisting in maintaining the strain against the wire. Should the trolley wheel leave the wire, the sudden movement of the pistons causes a charge of oil in the smaller cylinder to throw a valve, allowing the oil to enter the large cylinder under the plunger and shifting the air pressure to the other end of the cylinder, the whole acting as a dash pot and eventually bringing the pole to rest without having raised to any great extent. The trolley wheel used is the standard 6-in., "Kalamazoo" wheel.

Greenameyer Pneumatic Trolley.

Another interesting piece of apparatus built here is a trolley cross-over. This was designed for rapid service where the jumping of the trolley from the wire would cause a delay which could not be permitted and also possible damage. It is used particularly where one trolley wire crosses another at an acute angle, as, for instance, at Slauson Junction, where the Whittier line leaves the main trunk lines and crosses the inbound outer or local track.



Trolley Frog or Crossover.



Plan of Standard Depot.

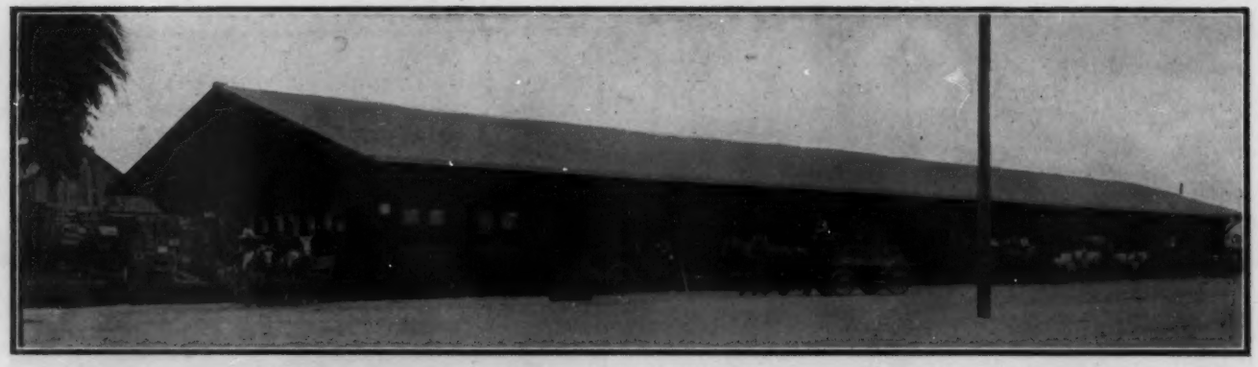
Various Types of Pacific Electric Depots and Shelter Stations.

Depots and Buildings.

Throughout the system depots or shelter stations are provided not only at all towns but wherever the passenger or freight traffic warrants the outlay. In all towns the depots are similar to those required in good steam railroad practice and follow two distinct types in appearance and arrangement. One type is for a frame structure while the other is concrete. They are conveniently equipped with open and closed waiting rooms, ticket office, baggage and express rooms, freight house and platform. Careful attention is paid to artistic surroundings and general appearance and well trimmed lawns, shrubs and trees are almost invariably in evidence.

The frame buildings are covered with shingled roofs. The concrete buildings have solid walls and metal tile roofs. The average cost of building these depots is $4500 for the frame construction and $6000 for the concrete.

There are many shelter stations in almost as many varieties of architecture. They vary greatly in size and cost. The reason for this is, that many of them are built by citizens or real estate companies oftentimes before the anticipated population would justify



Freight Depot, Los Angeles.

the railroad company in the cost of a station. In many cases the community has furnished lumber and all materials while the railroad has supplied the labor for construction.

(*Courtesy of Electric Traction Weekly.*)

Entrance to Train Shed, Los Angeles Depot.

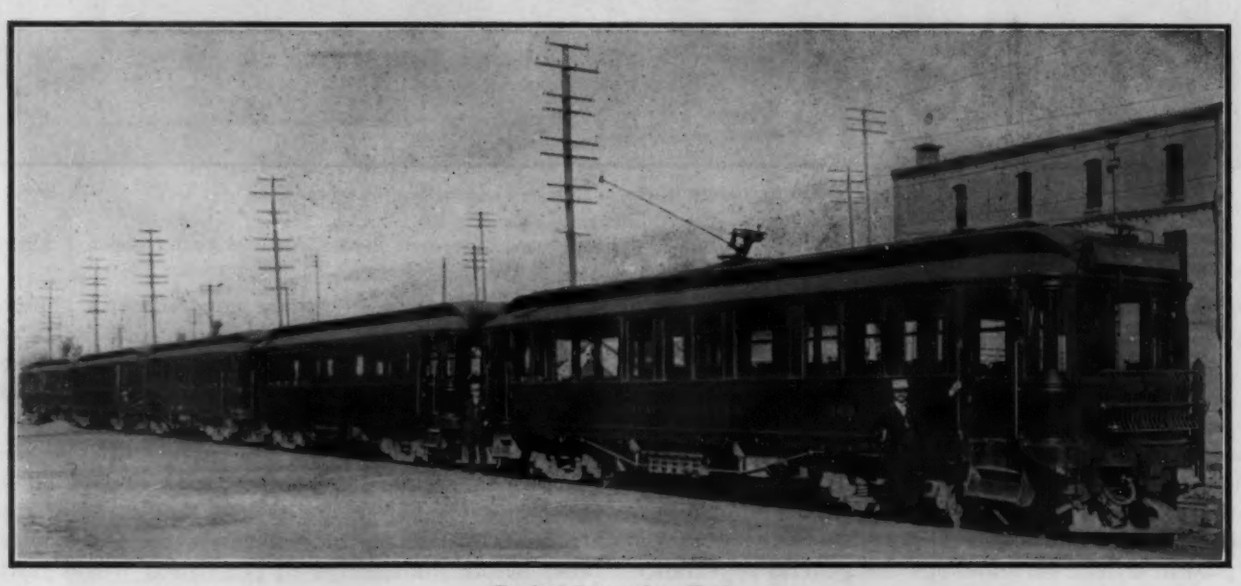
Rolling Stock.

The rolling stock of this system, except freight cars and flats, are almost all motor cars for the various uses. In the interurban passenger service, the cars may be classified under two general heads, the 200-h.p. and the 300-h.p. equipments. There are a variety of sizes and styles of motors as well as brake systems and trucks. All interurban cars have, however, the same general appearance.

All cars are painted red, or to be more explicit, crimson. A noticeable feature of the vestibules is that the corners are rounded, giving a neat and substantial appearance. The interurban cars are divided about two-thirds of their length by a partition with a door, this section being permanently enclosed. At the other end is also a partition with a door opening on to the vestibule.

The open end has no partition and is open to the vestibule. From the exterior, the appearance of the window openings are all alike, giving the effect of an ordinary closed coach, except that there are no sashes in the open section. The seats in the enclosed part are upholstered in red plush and are of various modern patented styles; in the open section the seats are of wood. The motorman sits in the center and at the open end is protected from being jammed by people entering or leaving the car by a nickeled pipe railing. The interiors are finished in mahogany with veneered ceilings.

An arc headlight is placed about 6 ft. above the level of the track and covered with a wire gauze screen on which is mounted an asbestos plate, having at the center a hole 3 in. in diameter. This concentrates the light on the track and prevents the blinding of persons



Typical Interurban Train.

approaching on the street or the motormen of cars running in the opposite direction.

Motor and brake equipments have, in nearly all cases, been furnished by the Westinghouse Company, although there are a few General Electric equipments on some of the smaller cars. The Westinghouse pneumatic multiple unit control is used for interurban work and all of the newer cars are so equipped.

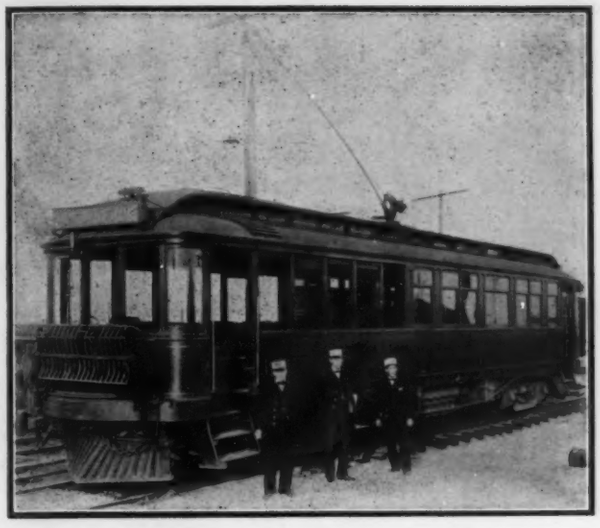
Following is a complete list of all rolling stock in use on the road:

PASSENGER CARS.	Total.
Observation Cars	7
Inspection Car	1
Passenger Motor Cars	367
Passenger Non-Motor Control Cars	18
Passenger Trailer Cars	2
Passenger Motor Cars at Mt. Lowe	3
Passenger Motor Cars at Riverside	15
Passenger Trailer Cars at Riverside	2
Incline Cable Cars at Mt. Lowe Incline	2
Horse Cars	2
Total	419
COMBINATION CARS.	
Passenger and Express Motor Cars	9
Passenger and Express Trailer Cars	1
Passenger and Mail Motor Cars	4
Total	14
Express Freight Motor Cars	20
Motor Wrecker Cars	2
Motor Tower Cars	4
Motor Power Cars (1 PE. Motor Power Cars at Riverside).	18
Electric Locomotives	4
Steam Locomotive for Construction Work	1
Portable Substations on 50-Ton Steel Flats	2
Caboose Cars	3
Tool Cars	4
Steam Pile-Driver on 50-Ton Steel Flat	1
Pile-Driver Tender (oil and water tanks on 40-ton flat cars	1
Steam Roller	1
Bonding Cars	2
Lidgerwood Rapid Unloader (on 50-Ton Steel Flat)	1
Western Spreader Car	1
Total	65
FREIGHT CARS.	
Box Cars.....80,000 pounds capacity	125
Flat Cars.....80,000 pounds capacity	1
Flat Cars.....30,000 pounds capacity, 1 P.E. flat at Riverside....	8
Flat Cars.....60,000 pounds capacity	1
Flat Cars.....30,000 pounds capacity	33
Flat Cars.....100,000 pounds capacity, steel	7
Dump Cars....30,000 pounds capacity	3
Dump Cars....60,000 pounds capacity	200
Dump Cars....80,000 pounds capacity	10
Dump Cars...100,000 pounds capacity, steel	49
Gondola Cars..80,000 pounds capacity	57
Beet Cars.....80,000 pounds capacity	50
Oil Cars.....6,530 gallons capacity	4
Oil Cars.....6,500 gallons capacity	15
Total	563
Total all cars	1,061

There is a large amount of local freight and express business, including milk shipments, which must be rapidly and readily handled. A special type of express car is used for this purpose. These cars are quite similar to the interurban class except that the car body is fitted for express and, in some cases, mail service. These cars do light switching and are capable of hauling several loaded freight cars. In the accompanying view one of these cars is shown unloading at the Los Angeles freight shed.

There are four electric locomotives, one of them being of steel construction throughout, with a total weight of 102,800 lb.

Most of the freight and heavy switching work is done with work motors. These are flat cars under which have been placed four-motor-equipment trucks and automatic air brakes. The heaviest of the work motors weigh 70,000 lb. The gear ratio is, in most cases, 21 to 61.



Typical Pacific Electric Interurban Car.

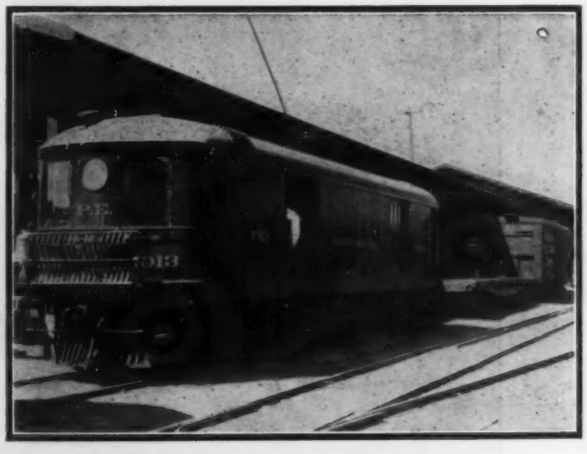
There are four tower cars, all with two-motor equipment and two wrecker cars with the same equipment as the work motors.

The equipment of the newer interurban passenger cars is as follows:

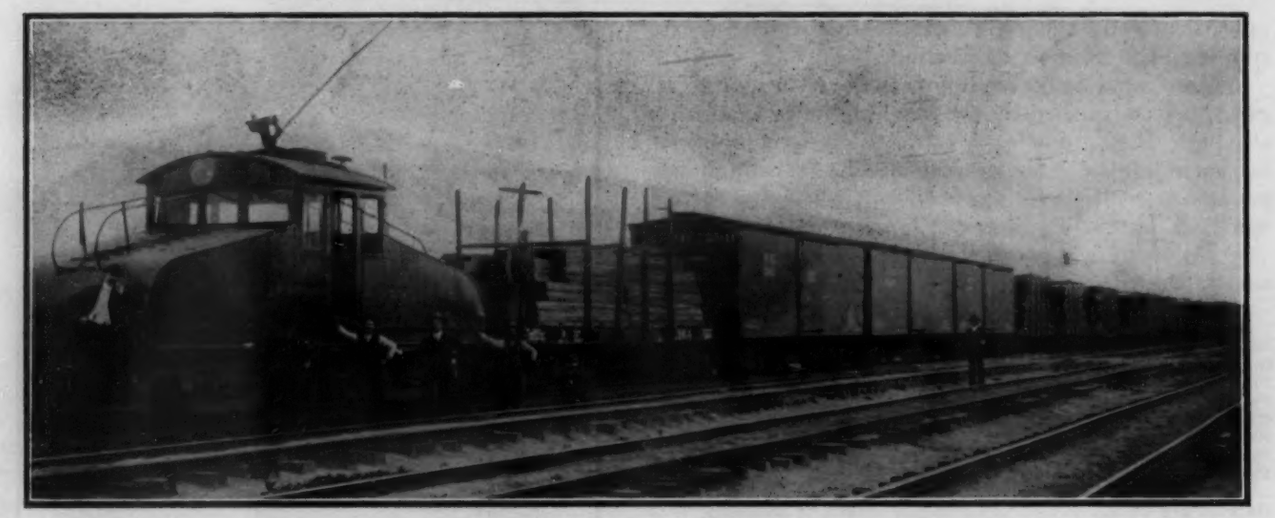
Control: Multiple Unit.
Motors: 4 Westinghouse No. 112.
Trucks: 6 ft. 4 in. Class "A."
Gear Ratio: 28-61.
Axle: 5 in. by 9 in.
Gauge: Standard.
Brakes: Westinghouse Automatic No. 5½.
Seating Capacity: 56.
Length: 50 ft. 10⅛ in.
Weight: 69,600 lb.
Maximum Speed: 55 miles per hour.

Operation and Traffic.

The system is divided and operated in three divisions, all under the supervision of a general superintendent, Mr. Thomas McCaffery. The Southern division includes the Whittier, Newport, Santa Ana and San Pedro lines and connections and enters Los



Typical Pacific Electric Express Car.



Regular Freight Train and Steel Locomotive.

Angeles over the four-track trunk line between Watts and that city. The superintendent of this division is Mr. F. Van Vranken.

The Northern division begins at Los Angeles, includes the four-track trunk line to Oneonta Junction and the various feeders, the Glendora, Covina, San Gabriel, Pasadena Short Line, Pasadena Oak Knoll and Pasadena Old Line and the Sierra Madre line. This division is under the supervision of Mr. J. B. Rowary.

The third is known as the Los Angeles City division and includes all of the city lines, the Gardena line (narrow gauge) to San Pedro and the Glendale line. The superintendent is Mr. J. C. McPherson. The Pasadena local lines and Mt. Lowe Railway are operated by Mr. A. B. Wells, superintendent at Pasadena.

Each division has its own corps of dispatchers. There are eight in all; three each for the Northern and Southern divisions who work eight-hour shifts; and two on the City division, working nine-hour shifts. The dispatchers' offices are on the second floor over the train shed in the main depot at Los Angeles.

Trains are all handled on schedules which are so

(*Courtesy of Electric Traction Weekly.*)
Interior of Train Shed, Showing Arrangement for Automatically Reversing the Trolley, Los Angeles Depot.

arranged that a train has from five to seven minutes' leeway in a round trip from the main depot to terminal and return. Should a train be delayed for any reason and not arrive before its next leaving time, a new train is made up to run on the schedule and maintained until such time that the regular can start again on time. A number of cars are always in readiness for this emergency, being held on the elevated viaduct track at the rear of the train shed. Special trains are made up on advice of the passenger department, giving the number of people and are run as extras.

Train dispatching is done by telephone, Western Electric Company's phones being used exclusively The conductor reports the arrival and departure at terminals and the number of cars in his train. In case of delay, communication is maintained with the dispatcher from the stations or telephone boxes along the line.

On single-track sections, standard orders are used and before passing from double to single track the conductor gets from the dispatcher, orders or a clearance. The dispatcher is also notified when passing from single to double track.

Owing to the great number of lines and frequent service the system of dispatching must work accurately and with the least possible delay. The train upon arriving at the main depot must await its turn, receiving a semaphore signal at the proper moment. The train passes through the train shed, taken to the rear and awaits its turn, then it is immediately shunted to the outgoing track and takes its position to receive its passengers.

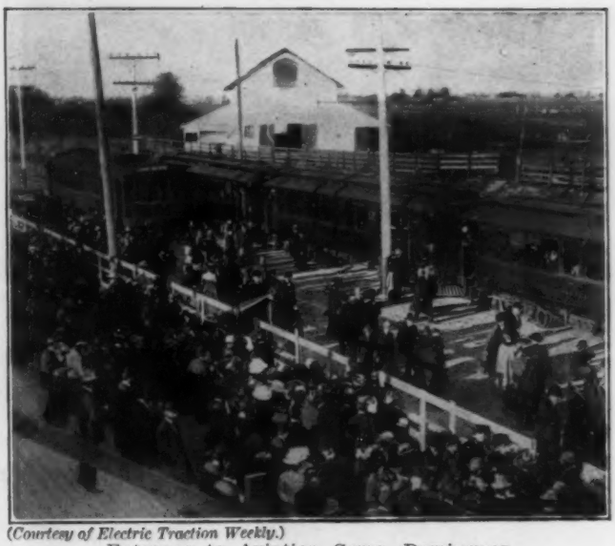
In switching, an ingenious device is used to turn the trolley. This consists of a series of inverted troughs arranged like a Y switch. These troughs are lined with sheet copper which is connected to the trolley wire; the wheel therefore receives current from any point on which it may bear in the trough. When the motion of the car is reversed, the Y trough forces the trolley wheel to the end of the Y until it is at right angles to the car and the further movement of the car draws it back through the other branch of the Y, finally restoring it to the trolley wire, but in the opposite position.

Trains are allowed from three to five minutes to get in and out of the depot. During the average 24 hour day, there are 1250 arrivals and departures of trains (not cars). This does not include local and city cars or express or freight cars, or special cars.

Trains are operated with one, two and three-motor cars, depending on the time of day and general traffic. Specials often consist of four or five cars, two or more of the cars being trailers or non-motor cars.

The cars are so constructed that once a passenger is seated, he cannot change to another car, unless he would wish to pay another fare, which is an invincible argument to make him keep his seat.

Every two-car train has a conductor for each car, the rear conductor acting as rear flagman. Each conductor collects the fares of his car only. With three cars, there are often but two conductors, the forward taking care of the two first cars, while the other handles the rear car and acts as flagman. In starting a train, the conductor on the forward car gives a bell signal only after getting electric bell signals from all other conductors.

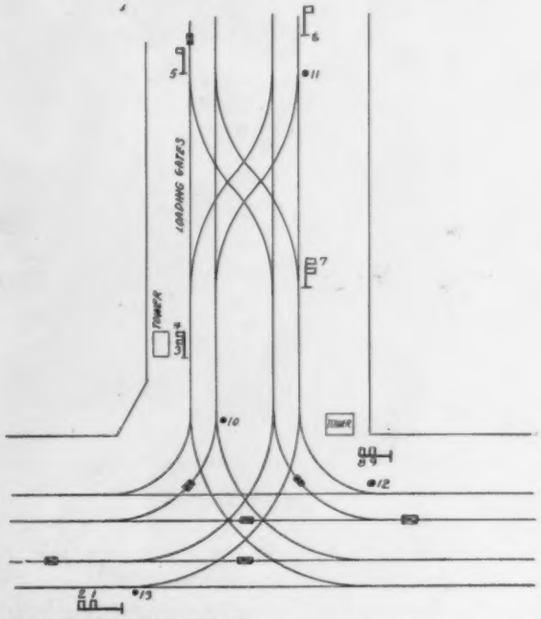


(Courtesy of Electric Traction Weekly.)
Entrance to Aviation Camp, Dominguez.

Conductors and motormen are paid at the same rate, 25 cents per hour during the first year of employment. After the first year the pay is increased 1 cent per hour each year until they have served five years, after which the rate remains the same. Conductors of freight trains are, however, paid 30 cents per hour after having been in service six months.

New men are first broken in on all lines; they then are required to pass an examination on rules by each division superintendent, and on equipment by a mechanical instructor. If these examinations are satisfactorily passed, the men are then placed on the extra list, eventually finding regular places as older men drop out, or as the operating requirements increase.

The passenger traffic is now so heavy that there is practically a steady stream of trains entering and



(Courtesy of Electric Traction Weekly.)
Plan of Tracks and Signals, Los Angeles Depot.

Freight Yards at Los Angeles.

leaving the main Los Angeles depot. The trains are either through trains, stopping nowhere on the trunk lines but at all the principal points on their respective sections, or "fliers," which make no stops until the terminal is reached, or locals stopping at points on the trunk lines. These latter trains (single cars, as a rule) do not, owing to the congestion in the main depot, enter or leave that station, but leave from an outside point nearby.

On the trunk lines, the two outer tracks are used for local and freight traffic, while the inner tracks are reserved for the through and express traffic.

While it is difficult to secure the total number of passengers traveling on an average day, some idea may be gained from the fact that, between Los Angeles and Pasadena alone, there is a through traffic of 23,000 persons in an average day. Between the hours of

San Gabriel Mission.

4:30 p.m. and 6:30 p.m. on the through trunk of the Northern division, trains are operated with one minute headway, while on the Southern division the headway is five minutes.

To give some idea of the amount of travel between Los Angeles and the beaches, 24 to 40 miles distant, there is a 20-minute, three-car train service maintained between the hours of 8 a.m. and 8 p.m. to Long Beach alone and on Sundays this service is maintained at 10-minute intervals. Every third train on the Long Beach line is a "flier," leaving Los Angeles on the even hour and occupies from five to seven minutes less time than the regular trains in making the run.

The company handles a diversified freight business. Switching and hauling gravel and crushed rock is done with freight motors. There is always much of this work as there is being hauled an average of 40 cars a day for the Pacific Electric's use in grading. Municipal requirements average 30 cars more. About 30 cars of sugar beets are delivered to the beet sugar factory near Santa Ana per day and as many more are delivered to the steam railroads for transportation elsewhere. Local freight and the transportation of milk and vegetables is handled by the standard express cars. These cars also do light switching and are capable of hauling several loaded freight cars on fast schedule.

In the main depot at Los Angeles, the passenger waiting rooms are adjacent to the outgoing track. The system of handling the many passengers without confusion is at once simple and effective. There are 10 doorways opening from the waiting room to the station platform and in front of each is a brass railing so arranged that the passengers in passing out to a train must do so in single file. The gateman stands in a space provided within this railing to examine all tickets. Over each of the doorways is an electric sign arrangement on which is etched the name of several of the principal towns of a particular line. When a train is in position to take passengers the names of the towns reached by the train appear upon the ringing of a gong, being made visible by a white board which falls in place behind the letters and which is electrically actuated from a switchboard operated by the towerman in the train shed. The gateman at the same time calls out the train and the names of the stations.

The Passenger Department.

The passenger department, under the supervision of the general passenger agent, Mr. D. A. Munger, is largely responsible for the half million and more tourists and numerous conventions whose annual patronage has made profitable much of this system's wonderful development. Attractive literature, a model of its kind, has been so widely disseminated throughout the world by this department, that there is no tourist and no convention unfamiliar with the hotel accommodations and sight-seeing inducements of Los Angeles and vicinity.

Substation Equipment and Power Supply.

Like every other part of this system, the idea of standardizing has been followed in the arrangement and operation of substations and the supply of power, in so far as it has been possible, considering the advances and changes that have been caused by the rapid increase in the demand for power and the refinement of the art.

There are 22 substations in active operation, 2 portable substations which may be shunted and placed in service on short notice at any point on the network where it may be necessary to centralize a large amount of power; and 1 central station in active operation in Los Angeles. The substations and electrical operation are under the supervision of the electrical engineer, Mr. S. H. Anderson, one of the department heads who has been with the system since its start.

Of the substations, there are two general types, and descriptions of an example of each type will suffice to convey a comprehensive idea of the entire equipment.

The older type, which in general appearance was well standardized, applies to 20 substations; the buildings are of brick with buttressed walls and plain gable roof, the latter having patented roofing covering, supported on timber purlins and trusses.

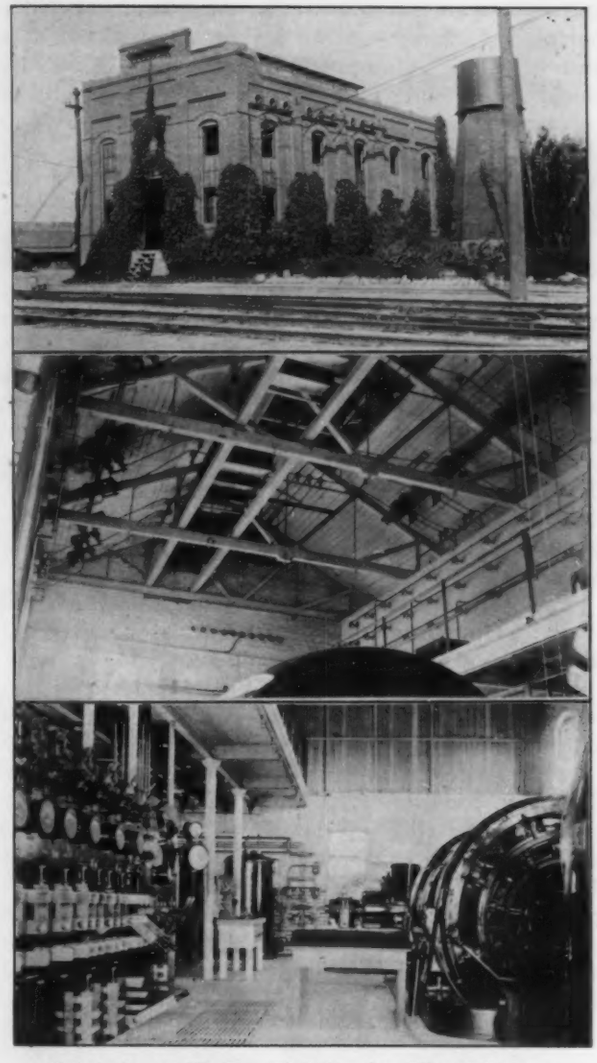
The windows, of size and number to give ample light, are distributed between the buttresses and above them immediately under the eaves are the openings for the high tension lines which consist of 12-in. sewer tile. The 600-volt outgoing feeders, as a rule, are brought through the front wall, or the side nearest the track and are carried directly to the trolley and the line feeders. In many cases a water tank mounted on a timber structure supplies a constant head for cooling transformers and in some instances where water is difficult to get, i.e., where it must be pumped, a cooling tower is mounted on the roof of the building. The interiors are calcimined throughout in a light color or white, giving a pleasing and airy appearance, while the grounds surrounding the buildings are laid out in lawns and shrubbery and in many cases a profusion of climbing vines and semi-tropical foliage turns the ordinarily plain industrial building into a beauty spot.

The arrangement of apparatus is invariably simple and efficient. Motor generators are used throughout and occupy a large part of the main floor. The switchboards are similar in equipment and follow standard 600-volt practice, although in arrangement were designed by the engineers of this company.

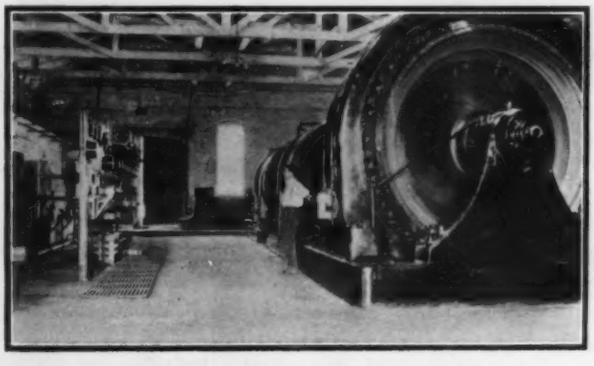
The transformers are all of 475-kw. capacity, having a voltage ratio of 15,000 to 2350-2200. In the older stations these are in sets of two, connected on the Scott system, receiving three-phase current on the primary side and delivering two-phase currents from the secondary. The newer units are, however, three-phase throughout and delta connected on both sides. The transformers are placed to the rear or side, but on the main floor, without the use of cells or compartments. The high tension switches are of the Kelman type and are placed on a gallery or shelf convenient to the incoming lines.

The substation at Watts, which is typical of the general style just described, is equipped with three motor generator sets. As this substation is one of the oldest on the system the equipment is not uniform, due to the additions which have been necessary from time to time, as the requirements on the plant have increased. The first set is a two-bearing Westinghouse and consists of a 600-kw., 600/550-volt, direct current generator, driven by an 850-h.p., 2200-volt, two-phase type "C" induction motor and operating at 415 r.p.m. The second set is made up of two Stanley self-contained machines; the generator is of 600 kw. capacity and is driven through a flexible leather link coupling by a synchronous motor. The motor is rated at 640 kw. and operates at 2200 volts, three-phase, with a speed of 375 r.p.m. Mounted on the motor shaft is a 5-kw., 120-volt, direct current generator to supply the necessary exciting current for the motor.

The third set is of a recent Westinghouse two-bearing type; the generator has the same specifications



Substation at Watts. High Tension Oil and Disconnecting Switches. Motor-Generators, Switchboard and Transformers.



Interior Pasadena Substation No. 2.

as the first set; it is, however, more compact and efficient and operates at the higher speed of 580 r.p.m. and the field mounting includes interpoles. A cast iron shield surrounding the field and armature on one side serves to give the air currents set up by the motion of the armature a uniform direction, thus acting as a blower which maintains a safe operating temperature in all parts of the windings.

The induction motor driving this set is 900 h.p. and operates with three-phase current at 2200 volts.

There are three sets of transformers, one for each motor-generator; the first consisting of two 475 k.v.a., 15,000/2200 volt, Scott connected three to two-phase, water-cooled Westinghouse transformers. The second set are three 220-k.v.a., water-cooled Stanley transformers delta connected on both primary and secondary, having the same voltage rating as the first. The third set is similar in size and make to the first, except that there are three transformers, supplying three-phase current at 2350 volts, being delta connected on both sides.

There are two 15,000-volt bus-lines which pass over the transformers and each set is connected to these lines through four-way disconnecting switches.

Mounted on a concrete and steel gallery are three sets of Kelman 15,000-volt oil circuit breakers, manually operated.

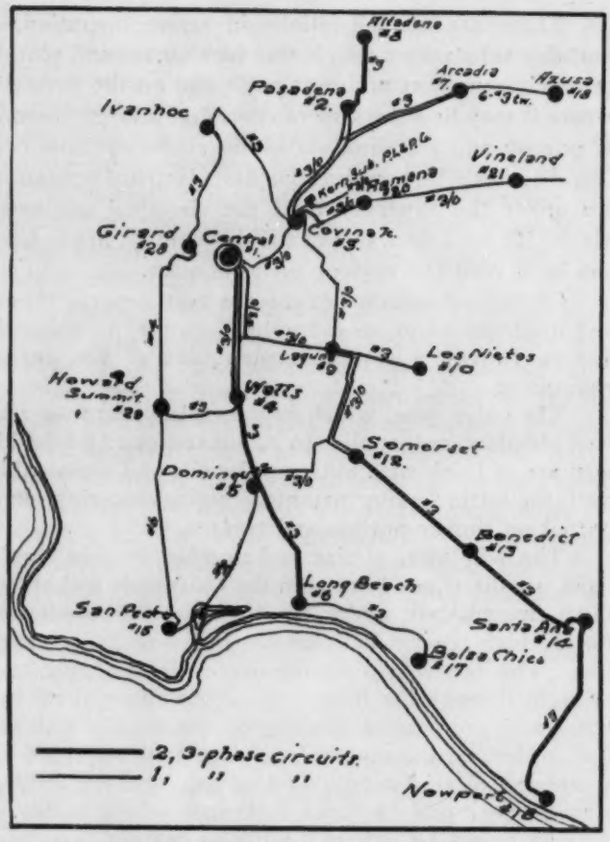
The switchboard, supplied by the General Electric Company, consists of 10 panels of black slate. Four of these are feeder panels and on them are mounted an ammeter, circuit-breaker and switch. The next three panels control, each, one of the direct current generators and are similarly mounted, while the remaining three panels control the motors and are equipped with oil-switches, voltmeter, ammeter and recording wattmeter.

This substation receives high-tension current, both from the central station at Los Angeles and from the steam plant at Redondo Beach. It therefore acts as a sectionalizing point and the circuits, three from each of the sources of supply, enter the building on opposite sides. After passing through double throw disconnecting switches are connected through three sets of Kelman 15,000-volt oil circuit-breakers. These are mounted between the roof trusses.

Of the more modern type of substations, there is one completed and in operation; this is known as No. 3 and is located at Covina Junction, on the trunk line of the Northern division and three miles from the central station in Los Angeles. The building is of reinforced concrete throughout and is therefore fireproof. It was built to take the place of an old and much smaller station near Eastlake Park and has the largest output of any of the substations. This requirement is necessitated by the multiplicity of lines and the enormous traffic which is centralized in the zone supplied from this substation.

Power is supplied from the central station and through it from the Redondo plant, also from the Kern River substation of the Pacific Light & Power Company. Aside from the lines brought to the substation from these sources, other lines radiate from it to other substations. It therefore acts as a sectionalizing station in the 15,000-volt distribution network.

Leading in and out of the building, there will



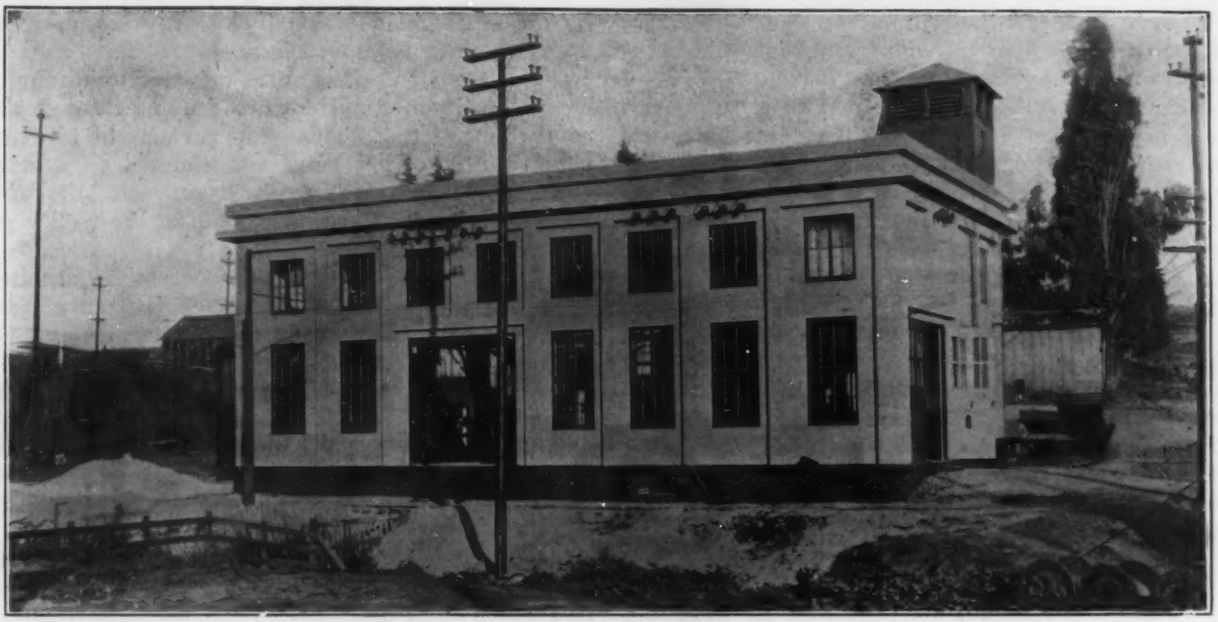
Map Showing Lines of the 15,000 Volt Power Distribution and the Position of Substations.

eventually be eleven 15,000-volt circuits, although nine are at present installed. These circuits pass through the walls in square openings on the front and the two ends. A cornice immediately above these openings prevents rain from driving through them.

Upon entering the building, the lines are carried to double throw disconnecting switches, and from each of these switches connection is made to two sets of Kelman 15,000-volt oil circuit-breakers.

A concrete gallery across the rear and the two ends of the building serve to support the Kelman pantagraph circuit-breakers or switches. As there are a great number of these,—28 sets when all are installed,—a unique arrangement has been adopted in order to confine them in the space alloted and at the same time make them accessible and give ample protection. The gallery is divided longitudinally by two parallel concrete walls about 2 ft. apart. On the outer side of each of these walls are arranged the Kelman switches, each set separated from its neighbor by a short transverse concrete wall, but open on the front side. Suspended horizontally from the longitudinal walls and directly over the lines of switches are two bus circuits; these are in three sections, but may be joined by disconnecting switches. The 15,000-volt lines after entering the building, pass down through the space between the parallel walls to double throw disconnecting switches suspended from the underside of the gallery floor, and thence, two circuits are carried up through the gallery floor, one to a rear set and one to a front set of Kelman switches. Current passes through these switches to the bus-circuits.

There are three sets of transformers and each is



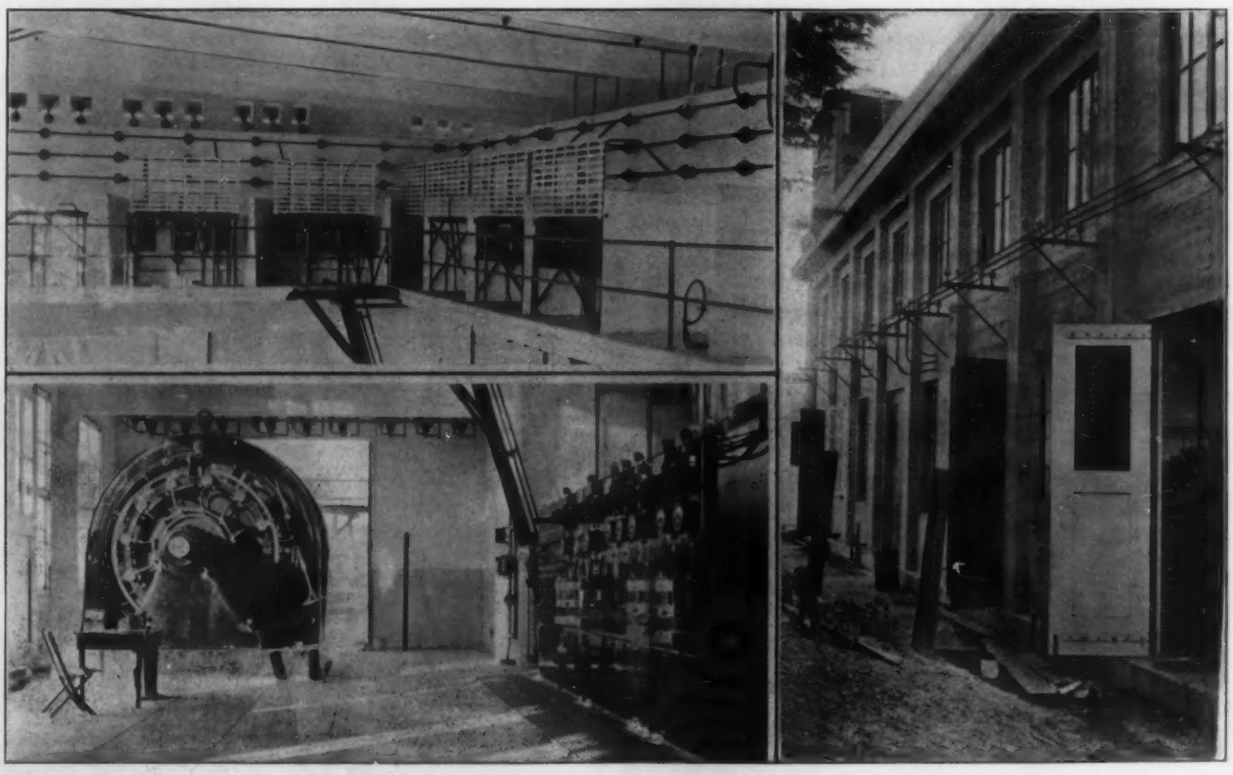
Substation No. 3 at Covina Junction.

supplied through two sets of oil switches, one connected to each bus-circuit and similar in type and setting to the line switches. They, however, receive their current from the bus-circuits and it then passes down through the floor to a double pole disconnecting switch and thence to the transformers.

The Kelman switches are operated entirely by compressed air at a pressure of 60 lb. per sq. in., the controlling valves being placed on the rear of the switchboard on the panels controlling the high-tension circuits. Hand operation is, of course, always possible by a lever mounted on the switch mechanism.

The three sets of transformers are placed, each in a fireproof compartment, at the rear of the building; two of the compartments are at either end and the third in the center. Large doors in the rear wall serve as an opening to these compartments, but there is no opening or passage between the compartments and the main interior.

There will be in each compartment three 475-k.v.a. Westinghouse transformers (the center compartment is not yet equipped), the voltage ratio being 15,000 to 2350, the standard adopted by this company. The transformers are delta connected on both sides.



Substation No. 3: 1—High Tension Switch Gallery; 2—Rear of Building Showing Transformer Compartments; 3—Motor-Generator and Switchboard.

The secondary circuits from the transformers are carried under the floor through Orangeburg fibre conduit to the motor-generators.

There will be three motor-generator sets, but two being in operation at present. These machines are highly efficient and modern, furnished by the Allis-Chalmers Company, and are of the two-bearing type.

The generator is rated at 1000 kw., delivering direct current at 550/600 volts, and is driven at 294 r.p.m. by a 2200-volt, three-phase induction motor, rated at 1500 h.p.

The switchboard follows the standard practice of this company, there being seven feeder panels, three generator and motor panels and three panels devoted to the high-tension switch system.

Mounted on the roof of the building is a cooling tower. Water is pumped through a Deming three-crank plunger pump, driven by a 1-h.p. General Electric induction motor through the transformer circulating system and thence to the cooling tower.

Compressed air to operate the Kelman switches and for cleaning purposes is supplied by two Westinghouse 3.85-h.p., d.c., air-compressor sets. It is delivered into two vertical tanks, made from iron pipe. These are 15 in. diameter and 15 ft. long, and pressure is automatically maintained by an electric pump governor.

At Pasadena the substation occupies the building, once a steam generating plant for the local system. There are three motor-generators, two being two-bearing Westinghouse equipments, similar to those used in many of the other substations, while the third is an Allis-Chalmers equipment and is similar to the machines in the new substation No. 3, just described.

Two sets of two each, Westinghouse 475-kw. Scott connected transformers supply two-phase currents for the two Westinghouse motor-generator sets and one set of three similar transformers supply three-phase current to the larger machines.

Portable Substation.

There are two portable substations, which, while relatively small in output, are by no means so in importance. The design of these substations has been carefully developed and the results have been most gratifying.

The car on which the station is mounted is a standard 40-ft. flat; the body is similar to the express car bodies, except that the ends are readily removed by the unfastening of four bolts. By this means the apparatus may be moved in or out.

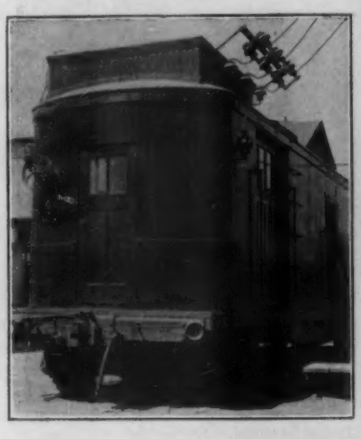
High-tension wires are introduced through a cupola on the roof, current first passing through a set of disconnecting switches. The car may be hauled on short notice to any point and shunted to a siding, connection being made to the 15,000-volt lines which are invariably mounted on the top of the trolley pole system on all routes.

To prevent vibration of the car from the machinery within, four standard 15-ton track jacks are placed under the car frame when the station is in use. One of these may be seen in the picture of this car.

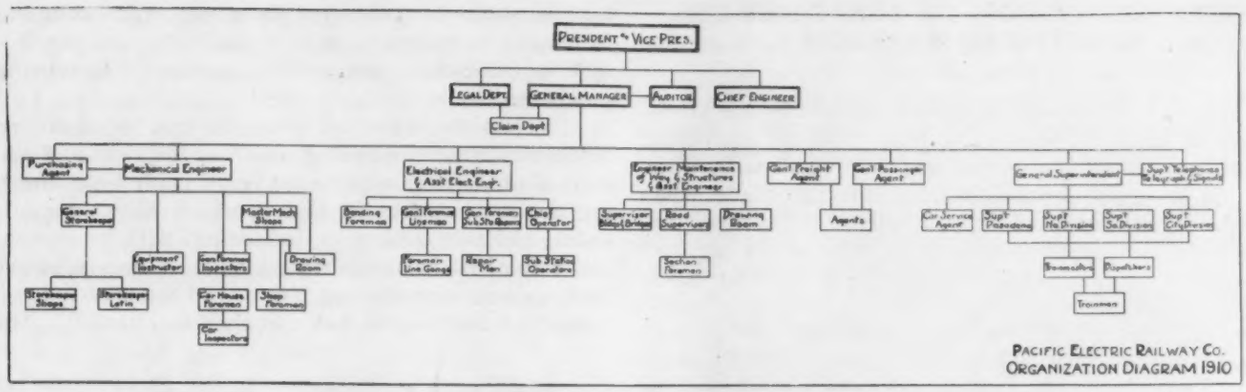
Directly under the incoming lines, within the car body, are three Westinghouse 475-kw., water-cooled transformers similar to those in the substations. Occupying the opposite end is one of the later 600-kw., two-bearing, ventilated Westinghouse motor-generator

EQUIPMENT OF SUB-STATIONS.

Station.	No.	A.C. Motor Horsepower.	Generator KW.	R.P.M.
Central	1	1500	1000	300
"		850	600	375
Pasadena	2	1500	1000	300
"		850	600	415
"		850	600	415
Covina Junction	3	1500	1000	294
"		1500	1000	294
Watts	4	900	600	580
"		850	600	375
"		850	600	415
Dominguez	5	850	600	415
"		850	600	375
Long Beach	6	850	600	415
"		850	600	415
Arcadia	7	550	400	375
"		850	600	415
Altadena	8	285	200	500
"		285	200	500
"		550	400	415
Laguna	9	550	400	375
Los Nietos	10	900	600	580
Somerset	12	900	600	415
Benedict	13	550	400	415
Santa Ana	14	900	600	500
San Pedro	15	900	600	500
"		550	400	415
Bolsa	17	850	600	415
Newport	18	900	600	415
Azusa	19	550	400	415
Ramona	20	900	600	580
Vineland	21	550	400	415
Ivanhoe	27	550	400	415
"		900	600	580
Girard Street	28	850	600	415
"		850	600	415
"		600	400	375
Howard Summit	29	300	200	500
"		300	200	500
Portable A		900	600	580
" B		900	600	580
Pomona		175	100	
"			40	
"			40	
Total		32,395	22,380	



Portable Substation: (1) Exterior: (2) 600 Kw. Generator: (3) Switchboard and Transformers.



sets already described. On one end of the shaft is a device known as a ball oscillator, for the purpose of giving the shaft a periodical end motion. This consists of a steel ball about ⅝ in. diameter bearing on the shaft-end in a circular track and on a stationary cap also in a corresponding circular track which, however, has a gradual hump. The ball covers the track once for every two revolutions of the shaft and in passing over the hump imparts the lengthwise motion to the shaft. A coiled spring at the other end maintains a pressure on the oscillator.

A two-panel switchboard in the center of the car controls the motor-generator, while a ½-h.p. General Electric motor and centrifugal pump delivers the circulating water from any convenient source to cool the transformers.

As an illustration of the possibilities of these portables; they have both been sent to the race track at Arcadia on Saturdays or holidays, where they were operated in parallel with the substation at that point, and where they would handle 85 to 100 loaded passenger cars within a space of 35 minutes.

The view shows the portable substation connected in the shop yards to augment the current supply within the city of Los Angeles.

Source of Power.

There are a number of sources whence power is delivered in large quantities in Los Angeles and the surrounding country; there are large steam plants and also water-power plants in the mountains, transmitting power, in some cases, 100 miles or more. In this article it is not intended that any of them shall be described

The Pacific Light & Power Company, a corporation entirely separate from the property described, own a number of the steam and hydraulic power-plants, and it is this company that delivers at several points, all of the electric energy required by the railway system. It is true that the railroad company owns the central steam generating plant in the city of Los Angeles, but even that plant is operated entirely by the power company and only at such time as the supply from other sources is inadequate.

The greater portion of the power is derived from the modern steam generating station at Redondo Beach. Electric current is generated at a potential of 15,000 volts, three-phase and with an alternating frequency of 50 cycles per second. This frequency is peculiar to this section of the country and was adopted, probably, in consequence of European practice, at a time when the long distance transmission of electric energy was in its infancy.

There are a number of transmission lines radiating from the Redondo station to supply the substations at different points on the system. During the Fall period of low water the hydraulic plants supply little power, but current from these plants is delivered to the Kern River substation near Eastlake Park and from that point delivered to the railway substation No. 3 at Covina Junction. This, it has been explained, is a sectionalizing point and from it the high-tension current is carried to other substations.

PROPOSED CALIFORNIA PUBLIC SERVICE COMMISSION.

At a meeting called by Meyer Lissner, chaiman of the Republican State Central Committee to listen to reports of legislation proposed for the next session of the California Legislature, Percy V. Long read a report from the committee that had been appointed to prepare a plan for a State public service commission, saying that the measure which it would submit would provide for a commission with the following powers: To issue permits to persons and corporations to engage in public service business; to compel complete publicity in the affairs of corporations and individuals engaged in public service; to control stock and bond issues of public service corporations; to authorize and require capital expenditures; to regulate and prescribe the terms on which franchises may be acquired, to control sales and leases of the property of public service corporations; to compel adequate service and the use of safety devices and to control construction in public service work; to determine the value of property devoted to public service; to assist municipalities in acquiring the property of public service corporations by acting as arbitrator or appraiser when requested so to do; to advise municipalities as to the reasonableness of rates to be fixed for public service.

The committee has not decided whether to give such a commission broad general powers, re-enforced by necessary amendments to the codes, or to follow the New York and Wisconsin plan, and provide in the act creating the commission all of the details necessary for the carrying on of this work.

RECONSTRUCTION OF SEMI-OBSOLETE ELECTRICAL MACHINERY.

BY H. ALTMAYER.

Foremost among the points brought to the attention of electrical engineers, both from an operating and commercial standpoint, are the questions of what to do with out-of-date electrical apparatus and what expense is warranted in adapting it to modern requirements. Single-phase alternators above 25 kw. capacity, especially those which were built for such frequencies as 125 and 133 cycles, are so nearly obsolete that it is usually best to consign them to the scrap heat. For small alternators, ranging in capacity from 5 to 15 kw., there is some demand for use on the low

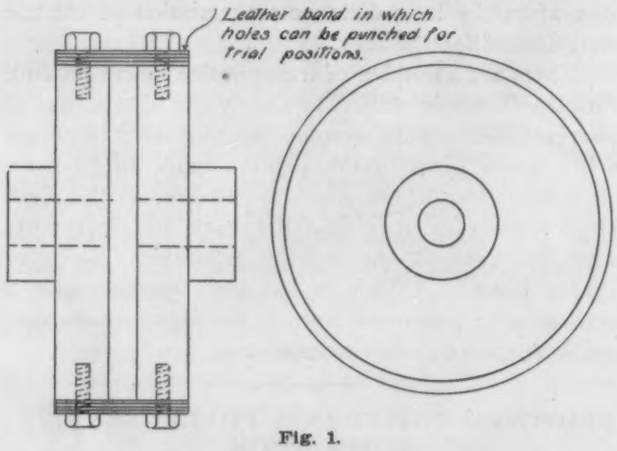


Fig. 1.

voltage lighting systems which now prevail and in conjunction with wireless telegraphy.

For tungsten lighting systems at places where there is no alternating current supply, 133 cycle apparatus can be used by running the alternator at about

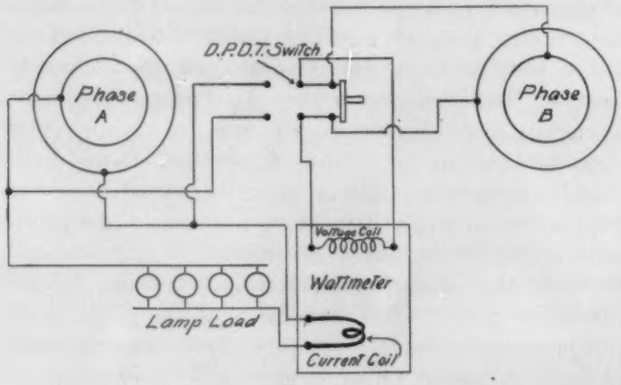


Fig. 2.

45 per cent of its rated speed, thereby giving the same ratio of voltage and from 30 to 50 per cent of the rated output, with fair regulation and not excessive friction, iron or copper losses. In San Francisco small alternators are frequently used for operating low voltage electric signs in conjunction with low voltage transformers by companies supplying only direct current.

It is also possible to mechanically connect two 60 cycle single-phase alternators, by placing their armatures in quadrature so as to obtain two-phase current, provided they have the same number of poles. The exact mechanical position of the two windings can be best determined by means of some mechanical coupling which can be shifted so as to place the armature windings in quadrature, one method for doing this being shown in Fig. 1.

The position of the two armatures can be determined mechanically within 20 degrees from the slots and coil ends, a closer trial adjustment being made by connecting the machines as in Fig. 2, which shows a wattmeter, either recording or indicating, with its current coil connected in series with a suitable non-inductive load, such as incandescent lamps, and the pressure coil connected first to phase A and then to phase B. The

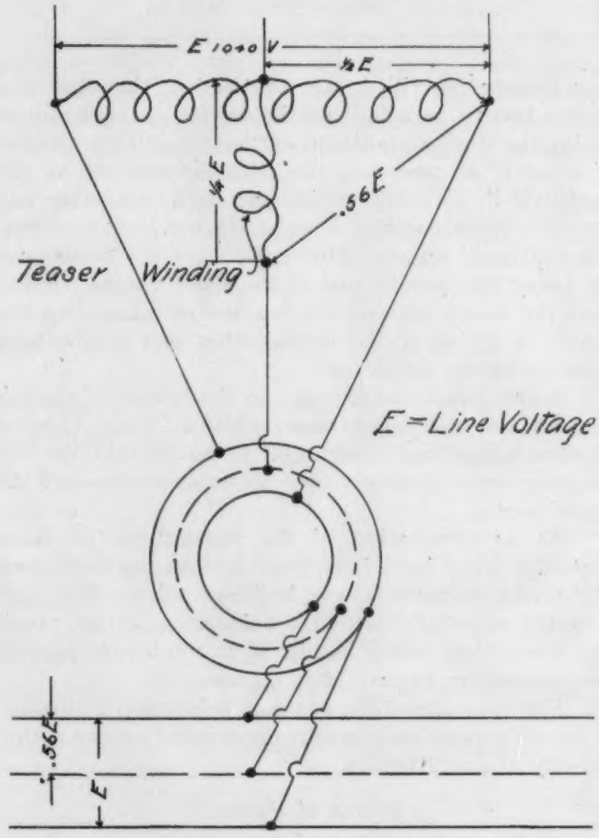


Fig. 3.

voltages of both machines should be kept the same during this test. When the flanges are adjusted exactly in quadrature the meter will give no power reading, as the load will be equal to zero power factor when the current coil is connected with one machine and the voltage coil with the other.

It is also possible after a first trial to compare the respective wattages of the two connections and to determine the error of the angle, which can be laid out on paper so that the subsequent tests will determine the exact angular position. A check on the phase conditions may be obtained by connecting the machines as two-phase, three-wire, when the voltage across the two outside wires will be 1.414 times that of one machine.

Monocyclic generators in vogue some years ago can be rewound to make satisfactory three-phase alternators. These machines were built in sizes up to 800 kw., usually being of the revolving armature type with compensated field windings. The writer recently had occasion to rewind such a 250 kw. machine with a volt-

age of 1040 and speed of 450 r.p.m. This generator was constructed with two sizes of slots in the armature, there being 16 coils in the main winding and 8 coils in the teazer winding. Fig. 3 shows the diagram of connections.

Although there were two sizes of slots it was found that they could both be utilized to hold the armature winding for a 250 kw. 2400 volt, three-phase generator by using square magnet wire and allowing 500 circular mils per ampere. There was enough room in

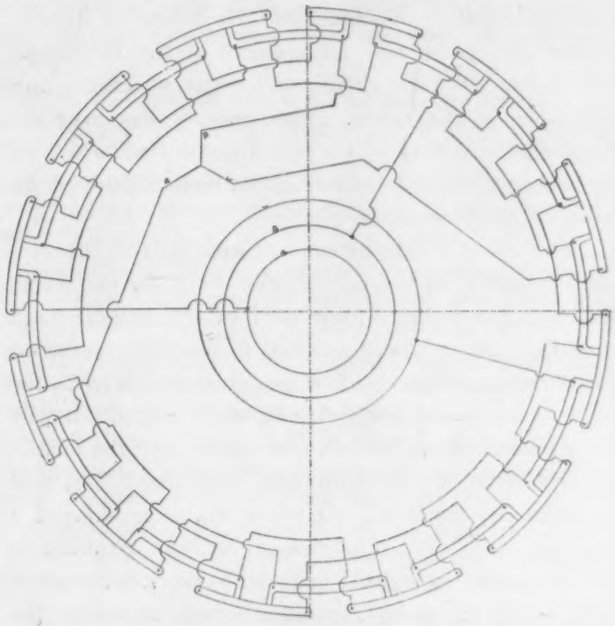


Fig. 4.

the small slots to allow ample insulation for this new winding, while the extra space in the larger slots was filled with extra slot insulation and heavier wooden strips. The armature contained 48 slots, 16 small and 32 large, the coils being originally spanned in 1 and 3 for the main winding and 1 and 4 for the teaser winding. Fig. 4 shows the new winding diagram.

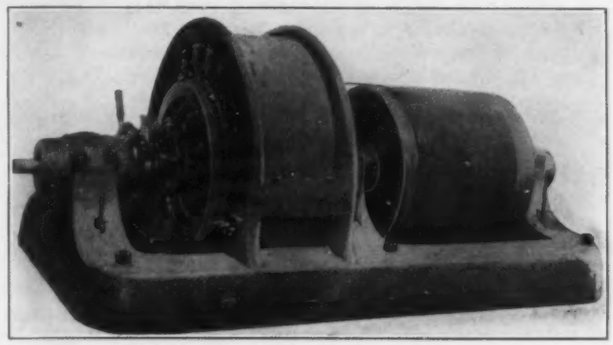
The rectifying commutator was disconnected and the compensating field coils were connected eight in series, two sets in multiple, and placed in series with the regular shunt field winding so as to strengthen the field. The no-load test on this machine was as follows:

Field Current.	A.C. Voltage.	Power Required
8.2 amperes	1440	8 h.p.
16 "	2400	10 h.p.
19.6 "	3200	16 h.p.

The field voltage on the last test was 108 volts. The impedance or short circuit test as conducted with full load current showed a field excitation of 7 amperes at 40 volts with a mechanical input of 7 h.p. A similar test of the single-phase alternator before stripping showed a field current of 12.5 amperes for full load current and mechanical input of 15 h.p. and field current of 21.4 amperes at a mechanical input of 21 h.p.

Comparisons of the monocyclic and the three-phase machine shows better regulation and much lower iron losses for the latter, both these tests being exclusive of the power taken by the exciter. The friction and windage losses of this machine was approximately 4.5 h.p., although the revolving element with pulley and shaft weighed about six tons. The weight of the entire machine was 16 tons.

This machine is now being operated in parallel with revolving field alternator supplying current to a number of induction motors, the larger being 125 h.p.



Monocyclic Generator Before Rewinding.

squirrel-cage types. The entire reconstruction was completed within thirty days after receipt of the machine, being done in the shops of the Farnsworth Electrical Works of San Francisco.

POWER RATES FOR ELECTRIC VEHICLES.

The Public Service Commission of Wisconsin recently decided that the Milwaukee Electric Railway & Light Company was justified in making a minimum rate of $5.00 per month for charging an electric vehicle. This was based on a rectifier capacity of 6 kw. The Commission called attention to the fact that such service is usually furnished at times of light demand and has been accorded a special rate by many companies. Before this complaint was filed the company had already established certain optional "off-peak" and "ten to seven" schedules.

Distinctive colors for high tension lines is suggested in France as a needed protection for aviators.

Corn growing in Alabama as undertaken by a chain of boys' corn clubs is the latest venture in the new South which finds its counterpart in the cotton growing now being introduced in California.

The largest oil tanks of reinforced concrete are the two reservoirs of the Union Oil Company at San Luis Obispo, California. Each is 601 ft. inside diameter and 20 ft. 4½ in. above grade and will hold more than 1,000,000 barrels of oil. Oil is pumped through the 200-mile 8-inch pipe line of the Producers' Transportation Company from the Bakersfield, Coalinga, Sunset, Maricopa, McKittrick and Midway fields.

No monopoly of the atmosphere is recognized by the court which recently decided that the Chicago, Lake Shore and South Bend Railway Company's 6600 voltage line does not constitute a nuisance even though inductive effect interfered with the working of adjacent telegraph lines. The court stated that if this effect interfered with the operation of the telegraph lines, the telegraph companies should provide such mechanical or electrical devices as would protect their lines.

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NOTICE TO ADVERTISERS

Changes of advertising copy should reach this office *ten days in advance of date of issue.* New advertisements will be accepted up to noon of Monday dated Saturday of the same week. Where proof is to be returned for approval, Eastern advertisers should mail copy at least thirty days in advance of date of issue.

Entered as second-class matter at the San Francisco Post Office as "The Electrical Journal," July 1895.
Entry changed to "The Journal of Electricity," September, 1895.
Entry changed to "The Journal of Electricity, Power and Gas," August 15, 1899.
Entry changed May 1, 1906, to "The Journal of Electricity, Power and Gas," Weekly.

FOUNDED 1887 AS THE
PACIFIC LUMBERMAN, CONTRACTOR AND ELECTRICIAN

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The Interurban Electric Railway

The great barrier that long separated town and country has been removed by the interurban electric railway, which brings health to the townsman, happiness to the countryman and contentment to both. To the farmer's boy the city has ever been the more alluring because he could not get to it, while to the city clerk it has been the more irksome because he could not get away from it. The interurban makes possible a country home for the city worker and gives city advantages to the ranchman. Each form of life has certain privileges which are now accessible to the other. The country develops the physical side of man by its pure air and food, while the city develops his mental side by its facilities for education and entertainment.

The electric interurban has also solved the economic problem of the costly short haul for the steam road and the tedious long haul of the wagon road. Electric traction is well adapted to frequent service at low rates, a service which is possible neither with the steam locomotive nor with the farmer's wagon. Before the advent of the telephone and electric car, the farmer was isolated not only from city enjoyments but also from the city markets. Oranges could be shipped a thousand miles almost as cheaply as ten. Prohibitive cost frequently forced the railroad to neglect the short haul, while the time consumed often deterred the farmer from a long wagon haul to market. Consequently many electric roads find a freight traffic which can be handled at times of slack passenger travel as profitable as a passenger traffic which is cheaper to handle because it moves itself.

The recentness and rapidity of this growth is indicated by the fact that but few dictionaries define the word "interurban," which was coined to distinguish this method of traction from the urban and suburban systems of which it is an outgrowth. Its first great difficulty, that of voltage drop over the long distances, was overcome by three-phase alternating current transmission and subsequent direct current distribution.

Though the interurban road has found its greatest field in the Middle West it will be but a few short years before the Pacific Coast is similarly gridironed. The story of the Pacific Electric Railway at Los Angeles, as detailed in this issue, shows how intimately it has been connected with the development of the surrounding territory. Though this system is now recognized as the peer of its kind, similar lines radiating from Spokane, Seattle, Portland, San Francisco and the interior towns of California are yet to tap a virgin country of even greater richness, thus promising extensions which will make it possible to travel from the Coeur d'Alene's of Idaho to the boundary line of California and Mexico.

PERSONALS.

S. N. Griffith, the Fresno electric railway builder, visited San Francisco this week.

C. P. Bockius is in charge of the power plant of the new Empress Theater on Market street, San Francisco.

R. D. Holabird, president of the Holabird-Reynolds Company, is visiting his branch electrical supply house at Seattle.

C. A. Bennett, representing manufacturers of railway car appliances, arrived at San Francisco last week from Los Angeles.

Arnold Pfau, chief hydraulic engineer of the Allis-Chalmers Company, is at the San Francisco district office of this company.

Dr. C. B. Laughlin, who has electric power interests in Northern California, arrived at San Francisco from Payne Creek last week.

C. H. Gaunt, general superintendent of the Pacific division of the Western Union Telegraph Company, is confined to his home by illness.

John Coffee Hays, general manager of the Mount Whitney Power Company, came up from Visalia to see the old year out at San Francisco.

F. B. Gleason, manager of the Pacific Coast branch of the Western Electric Company, has left San Francisco for a trip covering Portland, Seattle and Salt Lake City.

S. J. Lisberger, engineer of the electric distribution department of the Pacific Gas & Electric Company, made a trip through Northern California during the past week.

F. E. Shaw, who is interested in the Yosemite Power Company, a W. P. Hammon interest with an authorized capitalization of $10,000,000, is a San Francisco visitor.

J. V. Kunze, Atlantic manager of the Pelton Water Wheel Company, has returned to New York City after spending several weeks at the San Francisco plant of the corporation.

C. A. Coolidge, general manager of the Spokane, Portland & Seattle Railway Company, returned to his headquarters at Portland, Ore., during the past week, after spending New Year's at San Francisco.

A. R. Rhoades has arrived at the San Francisco office of the Western Union Telegraph Company from New York, for the purpose of introducing an improved system of accounting throughout the Pacific division.

P. M. Downing, head of the operation and maintenance department of the Pacific Gas & Electric Company, has returned to his San Francisco office after an inspection of the hydroelectric transmission lines.

The Farnsworth Electrical Works of San Francisco gave an enjoyable dinner to twenty-four of their friends and employees on the evening of January 1, 1911, at Jules Cafe. Informal speeches were made by all present, expressing a most commendable spirit of co-operation between employer and employee. The officers of the company present were H. Altmayer, president and assistant manager; H. T. Adams, secretary and manager; H. L. Rothchild, vice-president; A. Altmayer, and J. M. Jacobi.

A unique theater party was enjoyed by members of the "Engineers' Club" of San Francisco at the Empress Theater, on the night of December 20th, through the courtesy of Sidney Grauman of the management. Among those present were Messrs. George, Davis, Brewer, Herzog, John Carter, Jack Tranor, Phil Ennor, Herman Nothig, W. T. Bonney, William Jenkins, A. C. Arbuckle, Charles Elasser, and Joe Green. A lantern slide of a group of the members was thrown upon the screen at the show and Yeoman, the German comedian, made up a "local hit," upon each of the engineers in the party.

NEW CATALOGUES.

House Goods Bulletin No. 9550, from the Western Electric Company, lists in an attractive manner apparatus, appliances, tools and devices intended for everyday household use. The line carried by the Western Electric Company is complete in every branch of the electrical trade, though in this bulletin an attempt has been made to keep down to the actual "house goods" caliber.

The Westinghouse Department of Publicity have issued "Modern Merchandising Establishments Example No. 2" on the Higbee Company store in Cleveland—the first of the series being on the Marshall Field & Company store, Chicago. Although this series is published by the Nernst Lamp Company, still the advertising feature is shunned and a complete description of store arrangement and methods is given.

Dossert & Company have issued their Catalogue No. 5 on Dossert Solderless Connectors. It contains 62 pages 9x6 in., and gives complete information and dimensions of all types, sizes and parts of connectors. The stud connectors, the connector for grounding and short circuiting high tension lines, and the insulating covers for cable taps have not heretofore been shown. The book also contains useful information regarding the construction of cables, their diameters in mils and in inches and decimal equivalents, etc. It is completely indexed and code words are provided for convenience in telegraphing.

TRADE NOTES

The Pelton Water Wheel Company of San Francisco is making shipments under a contract with the Grangeville Electric Light & Power Company to Grangeville, Idaho. The plant will include a Pelton-Francis turbine of 550 h.p., direct-connected to a Westinghouse generator, operating under a head of 59 feet at 600 r.p.m. The wheel is of the double-runner cylindrical-case type. The plant carries a mixed power and lighting load for the town of Grangeville and the surrounding mining communities.

The Tracy Engineering Company of San Francisco has been appointed local sales agent for the Ridgway Dynamo & Engine Company, the well-known manufacturers of high-speed engines and of direct and alternating current apparatus, particularly of the Thomson-Ryan sparkless direct current generators and motors. The Ridgway Dynamo & Engine Company has recently brought out a new four-valve engine which has some features of special merit.

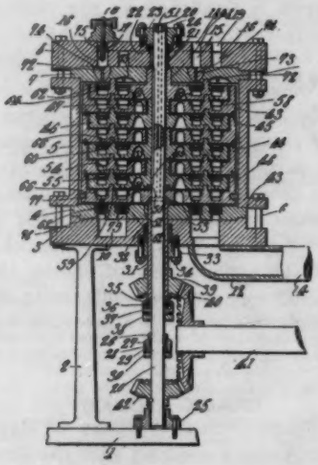
The Kellogg Switchboard & supply Company closed a number of deals during December, 1910, which indicates considerable development in the telephone field within the next few months. Contracts have been closed with the Exeter Home Telephone Company for a 200-line magneto switchboard; the Roseville Home Telephone Company, for a 100-line magneto switchboard, and the Moscow Telephone & Telegraph Company of Moscow, Idaho, for a complete two-section, six position central office equipment, arranged for four-party harmonic party line service. This installation will be complete with power plant, harmonic pole changes and subscribers' station equipment. All of these companies connect with the Long Distance system of the Pacific Telephone & Telegraph Company, and indicates an intention on the part of the various stockholders to furnish the public the most up-to-date telephone service obtainable.

THE FAR EASTERN REVIEW.

The November, 1910, number of the Far Eastern Review of Manilla, P. I., contains an illustrated account of the visit to China of honorary commercial commissioners representing the Associated Chambers of Commerce of the Pacific Coast who were the guests of the Associated Chinese Chambers of Commerce.

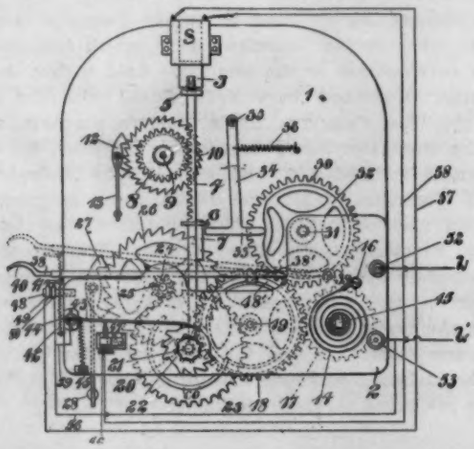
PATENTS

979,619. Turbine. Thomas J. Westerman, Olalla, Wash. In a device of the class described, a plurality of superposed rotors provided in their upper faces with concentric, inner and outer channels, the inner and outer channels of each rotor being alined with the inner and outer channels of the adjacent rotors and having communication therewith; racks removably mounted in the channels and



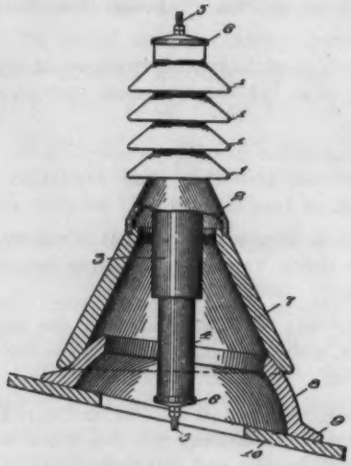
provided with blades inclined in one direction in the outer channels and in an opposite direction in the inner channels, to provide for a reversal of the rotors; each rotor being provided with an upstanding annular rib, positioned between the concentric channels of said rotor, and adapted to register in an annular groove in the superposed rotor, to prevent the passage of fluid under pressure from the inner to the outer channels transversely.

979,769. Electric Signaling Box. Arthur Kempston, San Francisco, Cal. In an electric signaling box, an electric circuit, a signaling mechanism, means to drive said mechanism, a slowly movable plunger adapted to hold the signaling mechanism in a position ready to send a signal at the first



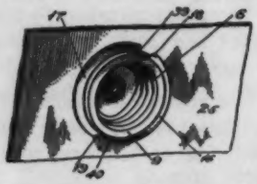
moment the line is clear of other signals, means to return the plunger to its initial position instantly if the line is operated during the period of initial movement of the plunger and before the signal has been started from that box, means to stop the mechanism, a solenoid for moving said plunger, and means to cut the solenoid out of circuit at the end of the set of signals.

979,840. Insulator-Base. Walter T. Goddard, Victor, N. Y., assignor to Locke Insulator Manufacturing Company, Victor, N. Y. The combination with the hollow lower base section having the upper exterior spherical surface and the upper



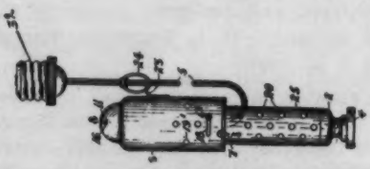
hollow base section having the lower portion fitting over and universally adjustable upon the lower section of an insulator embodying one or more petticoated insulating sections supported upon the upper edge of the upper base section and having the downwardly extending portion passing into the base.

979,927. Electric-Light Receptacle. Henry D. Brown and Lafayette W. Blymyer, Los Angeles, Cal. In a device of the class described, the combination of a sign base provided with an aperture with a notch in the edge thereof, of an electric



light receptacle and a locking member carried thereby, said member engaging the edge of the aperture at said notch by a rotary movement and pressing said edge on the inner side and outer side to lock said receptacle thereto.

979,905. Electric Sealing Device. Johann G. Wallmann, Oakland, Cal., assignor of one-half to Edward Pierce, Oakland, Cal., In an electric sealing device, the combination of a tube having a lower portion and a contracted upper portion,



a cap supporting a seal removably secured to the lower portion of said tube, a casing having a head containing a longitudinal opening and surrounding the upper portion of said tube and projecting over the lower portion thereof, a drum in said casing, and current conducting means leading into said casing and encircling said drum.

INDUSTRIAL

TYPE C WATTHOUR METERS.

The latest developments in the design of watthour meters are represented in the type C meters built by the Westinghouse Electric & Manufacturing Company of Pittsburg, Pa. These meters operate on the induction principle, which experience has shown to be in all respects the most satisfactory principle for alternating current meters, and are the result of a gradual evolution, covering a period of years, in which exhaustive experiment and intelligent study have played an important part.

The driving torque of the meter results from a shifting magnetic field acting on an aluminum disk. The shifting field is produced by the line current in a low resistance series coil and current in a highly inductive shunt coil connected across the line voltage. These coils are mounted on a laminated iron magnetic circuit of special design.

The design of the electromagnetic circuit is one of the most important factors in the operation of the meter. In the type C meter the circuit is closed on itself and therefore self-shielding, making the meter independent of stray fields. The arrangement is also such that most of the flux produced by the voltage coil passes through the gaps, only a leakage component combining with the series flux to produce rotation. This feature renders the meter accurate over a wide voltage range, by reducing the effect of varying permeability of the iron at varying voltage, and also prevents shunt field damping at high voltage, a serious defect in some types of meters.

The light load adjustment loops produce sufficient unbalance between the two limbs of the voltage flux to cause a friction compensating torque. Owing to this position of the no-load adjustment loops, however, this adjustment is entirely independent of current.

A feature of the Westinghouse meters is the micrometer light load adjustment. The position of the micrometer screws at the bottom of the meter element makes them accessible. The micrometer feature makes possible accurate adjustmnts.

Taken altogether, the combination of freedom from current effect, possibility of micrometer adjustment and accessibility, make an ideal light load device, free from creeping and having maximum accuracy.

The positive full load adjustment is another striking feature. The two retarding magnets are mounted on a heavy brass U-strap, the ends of which slide in machined ways in the mounting frame. This arrangement makes it impossible to twist the magnets out of alignment in tightening the clamping screws. Two clamping screws at each end of the U render the adjustment permanent in spite of shocks and jars.

The jewel and pivot type of bearings has been entirely eliminated in Westinghouse watthour meters. Instead a highly polished and specially hardened steel ball working between two cup jewels is used. As it is impossible to make the center of gravity of the moving element exactly correspond with the center of the bearing, the shaft has a slight gyratory motion which gives a rolling action to the ball. This produces considerably less friction than the boring action of the jewel and pivot and, by presenting constantly new bearing surfaces, assures an extremely long jewel life and permanent light load accuracy.

Permanence of full load accuracy is assured by the special aging treatment given to the retarding magnets and by the protection afforded by an iron shield between the permanent magnets and the electromagnet, which prevents any bad effects from the heavy fields produced by overloads.

The entire meter element is carried on a cast iron mounting frame so that it can be removed from the case as a unit without disturbing any adjustment. This allows adequate inspection in case of trouble and makes all parts accessible for repairs.

The full load torque of the type C meters is 42 millimeter-grams per phase and the weight of the moving element is only 15 grams per phase. This gives the high ratio of torque to weight of 2.8. The lightness of the moving element further insures long life of bearing jewels. The voltage coil is approximately 1.4 to 1.8 watts per phase at normal voltage, and the series coils produce a drop of .4 volt at full load.

Every meter has a guaranteed accuracy within 2 per cent, or from 2 per cent of full load to 50 per cent overload. This permanence of the meters is so reliable that these limits can be depended on even after shipment. No adjustment is necessary at installation nor need the case be opened to remove supporting wedges or release the movement. For this reason separate terminal chambers are provided for making connections, retaining the original seals on the meter element. This not only preserves the Westinghouse guarantee of accuracy, but prevents dust entering the meter at installation.

Type C meters are built in all forms demanded by commercial needs. House service meters, both single-phase and polyphase, with metal or glass covers, prepayment meters and single-phase and polyphase switchboard meters with metal and glass covers are described in the Westinghouse Company's publication No. 1137, just published. This publication also goes into the general principles of operation of watthour meters, and should be of interest to all those having to do with this class of apparatus.

THE NEW "IRONCLAD-EXIDE" BATTERY.

In line with its policy of progressiveness, the Electric Storage Battery Company of Philadelphia has recently developed a new electric vehicle battery, which will be placed on the market in 1911. This new battery will be called the "Ironclad-Exide" and is the latest and highest development of the "Exide" battery. It is the result of years of study and experimentation and long tests already made have proven its dependability.

The "Ironclad-Exide" battery is the perfection of a battery first invented by a Frenchman. The Electric Storage Battery Company secured the American rights on this patent about four years ago, and since that time has been carrying on experiments in an endeavor to perfect it. This has now been accomplished and under severe tests has shown the most satisfactory results.

The new "Ironclad-Exide" positive plate is so designed as to effectually prevent the loss of active material. The plate consists of a metal conducting top and bottom bar connected by vertical conducting rods. Each rod is surrounded by active material, which in turn is protected and held in place by a slotted hard rubber tube. This tube carries a vertical rib on each side which takes the place of wood separators, used with the standard "Exide" type of positive plate and makes the use of rubber separators unnecessary. A thin flat wood separator spaces the positive from the negative. The negative plate is a modified "Exide" negative plate thickened and improved, to enable it to withstand, not so much the increased capacity, as the truly unprecedented life of the new positive plate.

The "Ironclad-Exide" battery is claimed to give from two and one-half to three times longer life. The active material does not shed from the plates which eliminates the necessity

for ever cleaning the cells. It gives increased mileage and maintains this high capacity during the greater part of its life. Furthermore, it can be installed in standard "Exide" battery jars so that vehicle users having "Exide" batteries can substitute the new battery when requiring renewals.

This announcement of the Electric Storage Battery Company, the oldest and largest battery maker, which has devoted 23 years to the study and maintenance of storage batteries and a company whose recommendations in this field have always been conservative, should be of special interest to every electric vehicle maker, agent or user.

LARGEST HYDRAULIC TURBINE.

The engineering world will be much interested to learn that contracts have recently been awarded for the building of two hydraulic turbines, which will be the largest in the world. The Stone and Webster Engineering Corporation acting as consulting engineer for the Pacific Coast Power Company has placed an order with Allis-Chalmers Company for two 20,400 h.p. reaction turbines to be installed in connection with a new development on the White river.

This development is one of the most comprehensive undertaken on the Pacific Coast and the problems which have confronted the engineers have been extremely interesting as well as complex. The White river is fed by the glaciers of Mt. Rainier and receives its name from the milky silt which the river carries and which gives it a whitish color.

The development is about twenty miles east of Tacoma. The diversion dam is to be built at a point near the big viaduct of the Northern Pacific Railroad north of Buckley. This will not be of unusual size or strength and will simply serve to divert the water into a ditch discharging into a settling pond in which the silt will have a chance to be dropped. The headworks and gates will present some new features of design and will be made extremely strong. From the diversion dam the water will be carried through an earthen ditch about five miles long to the main storage reservoir. This storage reservoir is one of the most important elements in the entire development as it will hold enough water to operate the plant for a period of three or four months should no additional water be received. It is to be made up of several existing lakes which will be interconnected and which will have their capacities largely increased by the building of heavy embankments and masonry dams. The flow line of the reservoir will be about four miles long.

From the storage reservoir the water will be carried through a tunnel about 3000 feet long to the head basin. At present only one tunnel will be built but eventually another will be added. From the head basin a separate steel pipe line will be built for each turbine. These lines will be approximately 2200 feet long and will be eight feet in diameter at the upper end and six feet in diameter at the power house end.

The power house is designed for a total length of approximately 373 feet; 45 feet 7 inches of its width is to be used for the generating units which will be placed along this section with their shafts in line. Room is to be provided for six units although only two will be installed at the present time. The other side of the building, 26 feet wide, will be given over to exciter units, pumps, toilet rooms and transformer bays. Concrete foundations will be employed with brick superstructure.

The hydraulic installations will be supplied by Allis-Chalmers Company and will consist at present of two units, the largest ever built. These will have a maximum capacity of 20,400 h.p., each under a head of 480 feet. They will run at 360 r.p.m. Each turbine will be direct connected to a 60 cycle, 3 phase, 6600 volt generator.

The turbine runner is of the high pressure Francis type with horizontal shaft. Water will be admitted to the runner through a cast steel spiral casing. The runner, which will also be of cast steel, divides the water into two lines of flow and it is discharged from the wheel by two quarter turns to separate draft tubes. The flow of water to the turbine will be controlled by a cast steel butterfly valve.

In a turbine which exceeds all previously built, in point of both size and power, it is quite natural to find many parts that are larger or stronger than anything of the kind now existing.

The spiral casing of this turbine will be the largest steel casting of this kind ever made. The butterfly valve is to be over seven feet in diameter, and will be the largest valve of this type ever used. The shaft, carrying the turbine runner, will be nearly two feet in diameter and the bearings for it will be about 16 inches in diameter. All parts of the turbine which will have to withstand the operating pressure of the water will be tested in the shops under a pressure corresponding to about 900 feet head. To give an idea of the size and strength of the parts it is only necessary to state that the total testing load on the butterfly valve will be about one and one-half million pounds.

The governors for these turbines will be of Allis-Chalmers standard oil pressure type and the specifications call for extremely close speed regulation. Separate governors will be supplied for each unit but a rather elaborate central oil pressure system will be employed.

As this plant will have to regulate the supply of energy to the whole system of the Pacific Coast Power Company the problem of proper regulation is an important one. It becomes of still greater importance on account of the necessity of conserving the storage supply of water. To meet this condition and handle the water in a way which will protect the plant from injury and at the same time save water, pressure regulators will be installed. These are similar in design to those Allis-Chalmers Company is now installing on the 18,000 h.p. turbines in the Great Western Power Plant, a design which has done excellent service on other installations.

The size of the exciter units has not yet been definitely determined, but there will be two of at least 500 h.p. each. One exciter is to be provided for each three units of the ultimate equipment. As the proportionate amount of water which these wheels will use is not large they will be of the impulse type and will be governed by means of a deflecting hood similar to that used with the exciter units of the Kern River No. 1 station of the Edison Electric Company, built by Allis-Chalmers Company.

Construction is progressing rapidly under the direction of the Stone and Webster Engineering Corporation. Mr. S. L. Shuffleton, the Western representative of this organization, is in direct charge.

A REMARKABLE CABLE.

The Pacific Coast department of the Standard Underground Cable Company has received a sample of cable which has a very interesting history. The cable was manufactured at the Pittsburgh, Pa., factory of the Standard Underground Cable Company in 1886 and was installed in the city of Philadelphia in May, 1886. The cable was sold and manufactured for 600 volts working pressure and was operated at that pressure for several years when the working voltage was increased to 2000, at which voltage the cable was operated for several years and until a change in the system necessitated taking it out of service in September, 1910, after the cable had been in continuous service for twenty-four years and four months. The copper, insulation (fibre saturated with Ozite compound), lead and outer covering of saturated braid, are all in excellent condition and appear to be practically as good now as the day the cable was first placed in service over twenty-four years ago.

NEWS NOTES

INCORPORATIONS.

SAN FRANCISCO, CAL.—The Yosemite Power Company has been incorporated by John Hays Hammond and others with a capital stock of $10,000,000.

EUREKA, CAL.—The Eel River and Southern Telephone Company has been incorporated by H. D. Smith, E. M. Loveland, R. M. White and others with a capital stock of $20,000.

FINANCIAL.

ONTARIO, CAL.—The City Council has awarded the contract to the First National Bank of Ontario for the $95,000 worth of the $175,000 water bond issue.

ELLENSBURG, WASH.—The people of the city of Ellensburg, have voted in favor of a municipal water system for Ellensburg. The estimated cost is $300,000.

FALLS CITY, ORE.—The city will hold a special election on Monday, January 2, to vote on the proposition of bonding the city for $25,000 for a municipal water system.

SILVERTON, ORE.—The question of voting bonds to pay for the construction of a waterworks and sewerage system will be put up to the citizens and taxpayers of Silverton next week.

SIERRA MADRE, CAL.—By a vote of 123 to 20 the citizens of this city today voted to issue $40,000 municipal bonds to increase the water supply and establish a system of fire protection.

TURLOCK, CAL.—The town trustees have awarded $25,000 municipal sewer and waterworks bonds to N. W. Halsey & Co. for the sum of $23,025 the bid was accompanied by a certificate of deposit for $2,502.50.

SANTA ANA, CAL.—Another bond election will be called by the City Trustees for $35,000 with which to increase the pumping capacity of the city water station. About $3000 will be used for a well; $16,000 for a new pump and about $16,000 for strengthening reservoir walls.

ELLENSBURG, WASH.—By a vote of 7 to 1, the citizens of Ellensburg voted their approval of the council's scheme for installing a municipal water system in Ellensburg. The cost of the underaking is $300,000 and will be paid in bonds issued against the system and paid by 75 per cent of its gross income.

SAN FRANCISCO, CAL.—The public utilities committee of the Supervisors at a recent meeting set January 30 as the date for selling the initial installment of water bonds. Of the $1,125,000 realized through this sale $600,000 will be paid to William Ham Hall for the Lake Eleanor and Cherry Creek properties.

KINGSBURG, CAL.—At the regular meeting the City Council canvassed the bids submitted for the water bonds and the bonds were awarded to Adams & Co. of Los Angeles, whose bid was par, accrued interest and $254 premium and in addition to this they will print their own bonds. The lowest bid was par, accrued interest and a premium of $2.08.

SAN FRANCISCO, CAL.—The Supervisors at last week's meeting adopted a resolution by unanimous vote authorizing the sale of $1,125,000 of water supply bonds out of the $45,000,000 authorized to be issued to cover the entire cost of the city's Sierra water project. Bids for these bonds are to be submitted and opened on January 30 next, while six months later an equal amount will be offered for sale, and a year later another block.

TRANSMISSION.

CHICO, CAL.—President A. F. Smith of the Sacramento Valley Power Company announces the sale of a half interest in that corporation to the Fleishhacker Bros. at a price not made public. The company will be re-incorporated with a capital of $2,000,000, and bonds for an equal amount will be issued.

STAYTON, ORE.—A. L. Shreve, proprietor of the Stayton electric light plant, has purchased a power site three miles up the Santiam river from Stayton. The site is capable of generating about 5000 h.p. It is Mr. Shreve's plan to clean out the drift, build a headgate and do considerable other preliminary work this winter and in the course of a year or two build a big, modern power house on the site, which is on the north side of the river.

RED BLUFF, CAL.—A. G. Simpson of Chico has filed an appropriation of 8000 miners' inches of the water of Deer Creek. The purpose of the appropriation is to generate electric power. The power plant will be erected about 15 miles east of Vina. The water will be carried in a ditch 20 feet wide across the top, 14 feet wide at the bottom and 6 feet deep.

PORTLAND, ORE.—Dan. J. Malarkey, senator from Multnomah county, will introduce a bill creating a public service commission in the session of the Oregon legislature, which will convene at Albany early in January. The act will be one of the first measures presented for the consideration of the senate, and will provide means for the regulation of street car transportation, power, light, water, telegraph, telephone and all other corporations selling their goods to the people while making use of some of the property of the people. The bill will be modeled somewhat after the law now in operation in the State of New York, but it is not intended to divide the State into districts.

TRANSPORTATION.

FRESNO, CAL.—S. N. Griffith announces that he has withdrawn, with his associates, from the field as supporter of the proposed electric railroad between Clovis and this city. Failure to secure franchises desired from the city of Fresno is the reason Mr. Griffith gives for his action.

STOCKTON, CAL.—Having completed the grading between French Camp, a short distance outside of the Stockton city limits, and Modesto, the San Joaquin Electric Railway has applied for a franchise over McKinley avenue, which reaches the water front, and would give the new line considerable through freight business.

OAKLAND, CAL.—F. M. Smith says: "So many misleading articles have appeared in the press during the last few weeks that I think it best to correct them. While it is true that I have purchased from F. C. Havens and W. G. Henshaw their holdings in the Oakland Traction Company and Key Route and that I have sold to Mr. Havens my holdings in the Peoples Water Company, it is not true that I have sold any of my transportation interests to the Santa Fe Company nor have I had any negotiations with that company to that end. My plans are to give the cities on this side of the bay as fine a street car system and ferry system as brains and money will provide. I cannot at this time state in detail just what plans for such development have been determined on."

OROVILLE, CAL.—Announcement has been made at the office of the Western Pacific Railway that a traffic agreement has been signed between the Western Pacific and the Monticello Steamship Company and the San Francisco, Vallejo and Napa Valley Electric Railroad, whereby there will be an interchange of tariff between the local road, the steamship line serving Vallejo and the Mare Island Navy Yard and the electric line which extends from Vallejo thirty-five miles into Napa Valley.

SAN FRANCISCO, CAL.—Rails and other steel work of the Geary street municipal road will begin to arrive in March and construction work will start. This is the announcement made by Chief Assistant City Engineer H. D. Connick. The specifications for the side plates, connecting rods, trolley poles and wires will be reported to the Board of Public Works during the present week. There will be about 10,000 tons of metal in these side materials. In the steel rails there will be 2570 tons. About 70 tons of the steel rails have been turned out, including nearly all the curve connections. Engineer Connick says the curve connections will be much better than those of the United Railroads, for the reason that they will be made of manganese steel, which is more durable than the ordinary metal. It is not considered feasible at the city engineer's office to equip the Geary street line with the newly invented Edison storage battery cars. It is believed that the cars are somewhat in the experimental stage at present. Engineer Connick says it is proposed to secure for the city road coaches constructed entirely of steel, of the most improved type somewhat larger than the largest of the United Railroads cars, and fitted for a "pay-as-you-enter" system.

ILLUMINATION.

WILLOWS, CAL.—A franchise granting power to erect poles and stretch wires in the town of Willows for the purpose of carrying electricity for commercial purposes, has been sold to C. R. Wickes.

HOOD RIVER, ORE.—The Hood River Electric Light, Power & Water Company has been sold to the Oregon and Washington Electric Corporation, which is buying up power plants around this section, having recently secured the Vancouver plant. It is said the price paid for the Hood River corporation is $70,000, the purchaser to assume the bonded indebtedness, amounting to as much more.

BOISE CITY, IDAHO.—The Telluride Power Company, the Great Shoshone Falls Light & Power Company and the Boise Power, Light & Traction Company, are seeking to gain control of the electric power business of Southern Idaho. The Telluride Power Company is prepared to spend several million dollars in the completion of its Idaho plans. A. L. Woodhouse, general superintendent, was in Boise several days ago, accompanied by a party of engineers. The main power plant of the Telluride Company will be constructed near the confluence of the Malad and the Snake Rivers, and will furnish 10,000 h.p. to a line to run east and west across Southern Idaho. The Shoshone company is backed by Kuhn Bros. Its plant is on the Malad River at Salmon Falls. It arranged to run a line west through Southern Idaho, and to meet the competition of the Telluride Company at Boise. The Boise Power, Light & Traction Company filed articles for $1,000,000, half of which amount it is said has been subscribed in preparation for construction of a power plant on the Payette River above Horseshoe Bend and for extension of lines. The plant will develop 5000 h.p. and will cost $500,000.

LOS ANGELES, CAL.—The new electric power plant has been completed at Redondo Beach by the Pacific Light & Power Company at a cost of $1,000,000. The new plant is more than twice as large as any similar institution west of New York, generating 65,000 h.p. The plant was constructed to relieve the congestion in Los Angeles, as well as forming a resource for further extension of the Huntington and Pacific Electric properties. The power generated will be sufficient to give the downtown sections better service during the hours of heaviest traffic. The new plant is the expansion of the original power house at Redondo Beach, constructed three years ago, with a capacity of 25,000 h.p. The rapid growth of the electric lines intended for the use of this power was so great that by the time the plant was completed the demands of the electric lines and accessory uses were so extensive that the engines were run constantly at capacity. The power of the new plant will be distributed between the Pacific Electric and Los Angeles Railway companies. The Pacific Electric Company has arranged with the Pacific Light & Power Company for a supply of power which will continue by contract for several years. With the Redondo plant the corporation is producing in its various power houses in this State over 120,000 h.p.

WATERWORKS.

RATON, N. M.—The contract for the installation of the new Cimarron waterworks system has been let to Cook & Co. of St. Louis, Missouri, for $32,000.

COLVILLE, WASH.—Lewis P. Larsen has been granted a franchise to install and maintain a system of waterworks in Metalline Falls and the right and privilege also to build and operate a telephone and electric light system.

LOS ANGELES, CAL.—The Board of Supervisors will receive sealed bids up to January 30th for a franchise granting the right to lay down and for a period of 40 years to maintain a system of water pipes in the townsite of Lankershim.

TACOMA, WASH.—The Council has passed an ordinance providing for the construction of water mains ranging in size from 6 inches to 12 inches in Local Improvement District No. 564 in the city of Tacoma and cost of which is estimated at $38,555.

TACOMA, WASH.—Two bids have been rejected by Commissioner Nicholas Lawson of the department of light and water for the construction of the 100,000,000 gallon storage reservoir for the city's Green River gravity water system. Both were rejected because they were above Project Engineer J. R. Preble's estimate, which was $310,000.

BRAWLEY, CAL.—At the Council meeting last week plans and specifications for waterworks were accepted with slight modifications. Bids will be called for at once. The waterworks plan calls for a complete system but bids are arranged in such a way that the Brawley Water Company may have an opportunity to dispose of a portion of its 2 and 3 inch pipe on a competitive bid.

FREEWATER, ORE.—Freewater's proposed water system, plans for which have been under way for several months past, is soon to be a reality, the construction contract being signed by Mayor J. H. Hall at a special meeting of the Council, calling for the completion of the work by May 1, 1911. J. H. Jager, representing a St. Louis firm, has agreed to install the water system for $14,340, and take the city's recent bond issue of $16,500 at par.

FOREST GROVE, ORE.—The City Council has made a contract with O. B. Gates of Hillsboro by which he takes the surplus water of the Forest Grove Water system for a term of 10 years, at 4 per cent 1000 gallons. A pipe line will be built from the Forest Grove reservoir to Hillsboro and Cornelius and Mr. Gates will try to secure franchises with these two cities and with the people along the proposed right of way to supply the needed water.